A MUSEUM FORGERIES SERIES

REAL FAKE

The Story of a Zapotec Urn

Edited by Justin Jennings and Adam T. Sellen

REAL**FAKE**

Published by the Royal Ontario Museum with the generous support of the Louise Hawley Stone Charitable Trust. The Stone Trust generates significant annual funding for the Museum, providing a steady stream of support that is sued to purchase new acquisitions and to produce publications related to the ROM's collection. The Louise Hawley Stone Charitable Trust was established in 1998 when the ROM received a charitable trust of nearly $50 million—the largest cash bequest ever received by the Museum—by its long-time friend and supporter, the late Louise Hawley Stone (1904-1997).

Royal Ontario Museum 100 Queen's Park Toronto, Ontario M5S 2C6
www.rom.on.ca

Library and Archives Canada Cataloguing in Publication

Jennings, Justin and Adam T. Sellen, ed.
Real fake: the story of a Zapotec urn

Includes bibliographical references and index.

ISBN 978-0-88854-523-7

Cataloguing data available from Library and Archives Canada.

Managing Editor: Sheeza Sarfraz
Designer: Tara Winterhalt
Copyeditor: Dimitra Chronopoulos
Videographers: Joe Hoffman and Scott Loane

The Royal Ontario Museum is an agency of the Government of Ontario.

REAL**FAKE**

The Story of a Zapotec Urn

Edited by
Justin Jennings and Adam T. Sellen

ROYAL ONTARIO MUSEUM

Contents

Valley of Oaxaca from Atzompa.
Photo by Ángel Ramírez Luna.

Part II

Preface

Some objects in the ROM's collections are not what they appear to be. In this book, we set out to unravel the complexities of one particular object: an imposing ceramic effigy, acquired almost a century ago from Mexico. Is it ancient? Is it a fake? Or is it something altogether different? The intriguing results of our investigation—a study that began, many years ago, with a rejection— comprise the chapters of this book.

In 1999 a team of Mexican researchers was invited by the ROM to test its collection of Zapotec effigy vessels. The authenticity of many of the vessels had been in doubt for some time, especially after a previous study had demonstrated that there were numerous fakes among them. The researchers began to select which of the more than 120 vessels they would test. They came to the urn with catalogue number HM 1953 and removed it from its storage box for examination. Damaged in parts and heavily restored, the large and fragile urn was puzzling because it did not fit the researchers' notion of an ancient object, and it did not conform to what was then known about the fakes. The extent of the restoration it had undergone meant that it would not be a good candidate for a study that separated modern from ancient creations; so, having only briefly seen the light of the storeroom, HM 1953 was summarily repacked and returned to its shelf.

Fortunately, a chance encounter in the summer of 2015 led to a reassessment of HM 1953. One of the researchers from Mexico, Adam Sellen, stopped to chat with the ROM's metals conservator, Susan Stock. Sellen had always been intrigued by the incongruous combination of features on the piece. He felt that there may have been an identical companion to it in the Ethnologisches Museum Berlin, and perhaps another in a museum in Mexico. Sellen and Stock discussed some of the issues relating specifically to HM 1953: the nose was unusual, and the glyph on the headdress was nonsensical; the iconography of some of the features was correct, but other motifs did not respect

ancient Zapotec canon. Furthermore, some parts had obviously been restored, but which ones and when? Stock suggested that we could probe the object using a newly acquired X-ray head that would enable us to see through the object and perhaps offer a diagnosis of what had happened to the urn. The analysis would give us an indication of fabrication techniques, thickness, voids, breaks, and joins, and whether there was any reason to pursue a more active investigation.

Sellen and Stock approached Justin Jennings, curator of Latin American archaeology at the ROM, about X-raying HM 1953, and, a few months later, we did. There were audible gasps at the sight of the first images: the object was held together by metal wire. Definitively not a pre-Hispanic trait! A larger study was now warranted. We assembled a team of experts with diverse backgrounds in archaeology and the materials sciences to give us different perspectives on HM 1953's materiality and history. Much of the work happened in Laura Lipcsei's ceramics conservation lab at the ROM, where as technical lead she helped orchestrate our efforts to peel back the effigy's layers and separate out ancient parts from modern additions. We studied its history, tested and analyzed fragments, prodded and poked, all the time conscious that the concepts of "real" and "fake" are culturally constructed categories that might inform—or misinform—our findings. In the end, we were less interested in categorizing this object than in telling its fascinating story.

Of course, HM 1953 is part of a much larger narrative around the desire to collect Mesoamerican antiquities. The high demand for "exotic" cultural material from the ancient civilizations of the world, including Mexico's, gave rise to a burgeoning cottage industry that produced very convincing fakes at the turn of the last century. Later, the tourist trade fuelled production, and museums around the world unwittingly collected these newly minted wares at a feverish pace. Many museum collections are now rife with spurious objects, especially Zapotec urns because these vessels were one of the most sought out collectibles of the time. We know now that the ROM's collections from Mexico are central to the story of Mesoamerican "fakes" and our focus on HM 1953 has helped us understand this great caper in more vivid detail.

This book is divided into two principal parts. The first places the object in its archaeological and cultural context—how it was made, used, collected, and acquired by the ROM. The second part deals exclusively with the scientific description and analysis of the object's composite materials. It is important to realize that neither of these approaches exists in a vacuum, and information from both must be considered when attempting to determine whether any object is "real" or not. There are two ways to detect forgeries: by the human eye and by methods devised by modern science. Some scientists themselves admit to the primacy of the human eye, or visual analysis (often referred to as connoisseurship), since "an art historian relies on a mental data bank… and this, in itself, is a scientific approach".[1]

Connoisseurship is cultivated by the intense and close study of a body of work. The expert examines an object for its form and type, and compares

it to what is known about other examples from a specific time or context. Here experts take into account several factors, including but not limited to the object's form, its quality of workmanship and construction, and a general iconographic and symbolic congruency of elements. The collection history of the object (provenance) is also vital in establishing its origin. Of course, even the savviest of experts can be wrong, as history has proven time and time again. Thus the second part of the book focuses on testing, through more objective means, some of the questions, suppositions, and discoveries presented in the first part. The material analyses helped us answer specific questions about the urn's materiality, including how it was made, how it relates to other similar urns, when it was repaired and restored, which parts are ancient and which are not.

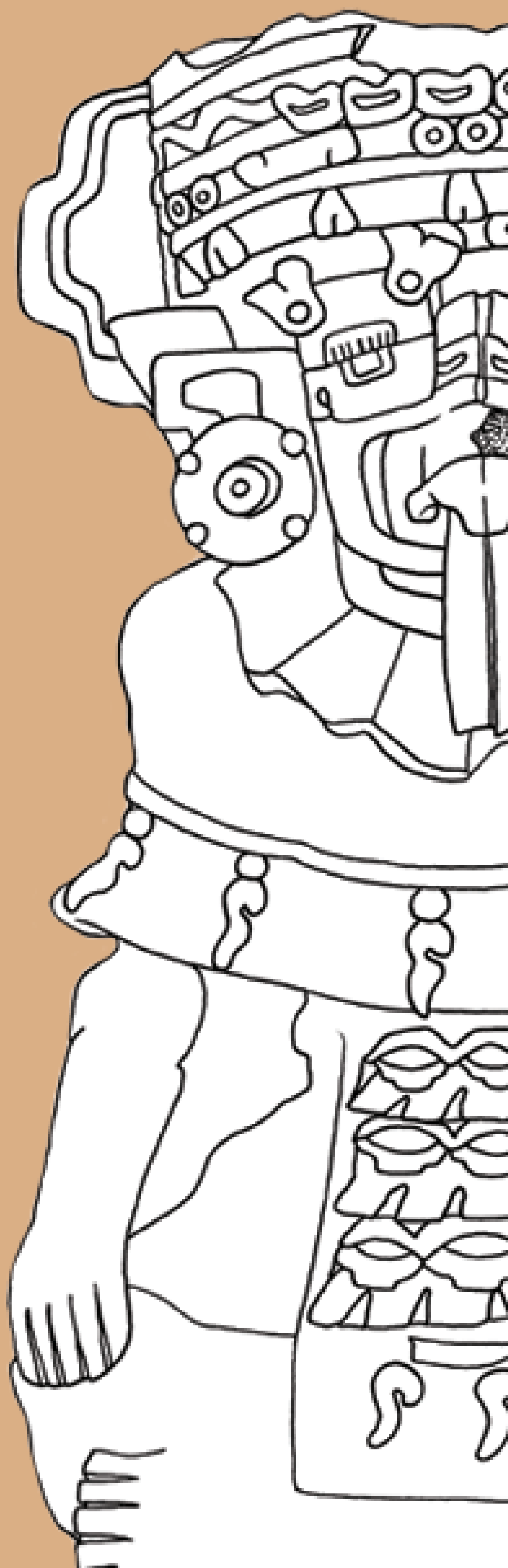
Taken together these studies have created a fascinating, though still fragmentary, history of HM 1953, an ugly duckling artefact that has been exceptionally cared for by museum stewardship, but sadly, was at risk of simply being ignored. Today we can share with the reader not only its complex biography, from an ancient tomb in Oaxaca to the storerooms of the ROM, but also the analytical and deductive process of how we came to know that story.

— Justin Jennings, Adam T. Sellen, and Laura Lipcsei

1 Stuart J. Fleming, *Authenticity in Art: The Scientific Detection of Forgeries*. New York and London, 1975, p. 3, 47).

Acknowledgements

We wish to thank Maria Gaida, Patricia Engelhardt and Matthias Farke from the Ethnologisches Museum Berlin for providing insight and expertise that greatly assisted the research. Christian Goedicke is acknowledged for providing the information on the thermoluminescence dating (TL) and the neutron activation analysis (NAA) of the Berlin urn (see Chapter 13). In Mexico, we extend our thanks to Sergio Bautista Orzuna, Director of the Instituto Nacional de Antropología e Historia (INAH), Oaxaca, and archaeologist Laura Freyre Valencia for their help locating the urn from Howard Leigh's collection in the storerooms of the Ex-Convento de Santo Domingo de Guzmán, Oaxaca, and allowing access to document it.



PART I

Some objects in the ROM's collections are not what they appear to be. In this book, we set out to unravel the complexities of one particular object: an imposing ceramic effigy, acquired almost a century ago from Mexico.

ADAM T. SELLEN AND JUSTIN JENNINGS

CHAPTER 1

Really Fake?

JUSTIN JENNINGS / ROYAL ONTARIO MUSEUM

In 1914, the Royal Ontario Museum (ROM) opened its doors to the public. Its director, Charles Trick Currelly, sought to build an encyclopaedic museum of world art and natural history. Canada was late to the game—the British Museum was founded in 1753—and the director and his small staff raced around the globe to uncover collections missed by rival institutions. As an archaeologist, Currelly was particularly concerned with obtaining objects from the earliest civilizations. Boxes arrived from Greece, Italy, Iraq, and China, but Mexico was one region that was woefully under-represented. So in 1919, Currelly took a train to Mexico City (Currelly 1956; Dickson 1986).

The ROM's Director arrived in a city littered with pre-Columbian objects of dubious provenance. Art experts had been alarmed by the proliferation of Mexican forgeries since the mid-nineteenth century (Kelker and Bruhns 2010, 37), and so the ROM's director sought out a collector of unimpeachable character. He thought he had found one in Constantine Rickards, a British diplomat who had sold and donated pieces to major museums in Europe and the United States. Rickards offered Currelly a collection of some 1,500 pieces of Zapotec art from Oaxaca that was dated stylistically to the first half of the first millennium CE (Sellen 2004, 36). Currelly seized the opportunity and fondly remembered the acquisition of the collection in his memoirs, published almost forty years later (Currelly 1956, 270).

The highlight of the Rickards collection was a group of 120 Zapotec urns representing gods and ancestors. Also known as effigy vessels, the urns capture the religious ideas that structured life in one of Mexico's earliest states. The urns were seen as a potent symbol of the ROM's commitment to the global coverage of ancient cultures and given a prominent place in the museum's pre-Columbian gallery. Then, many were tested. Beginning in 1977, a series of studies examined the urns via thermoluminescence (TL), a dating technique used to tell when a ceramic was last fired. Two-thirds of the samples were found to be of recent manufacture, likely made in ceramic workshops in Oaxaca a few years before they were purchased (Sellen 2004, 35). The ROM quietly separated out the newer urns from the rest of the collection. A few were sold as copies at the

museum gift shop, some were placed on exhibition as cautionary tales, but most ended up stuffed in cardboard boxes and arrayed on top of the New World archaeology section's storage cabinets—quarantined in second-rate packing material.

This book is about HM 1953, an urn from the Rickards collection that was never TL-tested (Figure 1.1). To our eyes, the piece appeared to be an Oaxacan Frankenstein—a new figure created in the early 1900s by combining ancient spare parts. The chapters in this book first contextualize HM 1953 by describing the Zapotec people (or *Beni Zaa* as they are known today), related urns, and the early twentieth-century art market. We then biopsy the object by irradiating it with X-rays, vaporizing samples for thermoluminescence dating, slicing out thin-sections, and ultimately disassembling it—all to better understand how it was initially put together. The result of these analyses is a more robust understanding of an urn that confuses our easy binaries of "real" and "fake."

"Is it real?" is a common question asked of museum curators. In the narrowest sense, all of our objects are real; they have substance and exist outside of our imagination. But this, of course, is not the thrust of the question. When someone asks "Is it real?", they are asking if the object in question was first produced by a particular person or culture in a particular place at a particular time (M. Jones 1992; S. Jones 2010; Phillips 1997). Museum goers tolerate—indeed *expect*—a few later interventions; they want pots glued back together, rust arrested, and a backing sewn on fragile textiles. Yet, conservators know that these interventions must not get in the way of the "authenticity" of the piece. Their mantra is that the "intension of the artist in its intellectual and historical contexts" must shine through (Scheidemann 2009, 6).

Composite objects like HM 1953 can be found in all museum collections (Geurds and Van Broekhoven 2013; Hermens and Fiske 2009). Yet composite objects have long tended to be kept off display once identified as such because they defy easy categorization. Archaeological artefacts in particular are meant to carry succinct object ID labels that bracket them in time, space, material, and theme (Figure 1.2). They are meant to represent to the visitor the Shang Dynasty, Imperial Rome, or the Zapotec. An object like HM 1953 carries a mixed message that runs counter to this objective. It is neither a complete forgery—a contemporary product created with the intent to deceive—nor wholly the creation of a Zapotec artisan living some 1,500 years ago. It is also not a replica crafted to duplicate an original artwork. Both ancient and modern, pieces like this urn have often been dismissed as "fake" or "inauthentic." Yet it is the fusion of thousand of years of history that often makes composite objects so interesting. (See Brulotte [2012] for a fascinating discussion of the production of replicas in contemporary Oaxaca.)

To tell the story of HM 1953 requires us to work against our gut impulse to categorically label objects as "real" or "fake." As you will see in the pages that follow, the bulk of HM 1953 is composed of pieces from at least three ancient Zapotec urns that were cobbled together with new parts crafted at the beginning

Figure 1: HM 1953, a Zapotec-style urn in the ROM's collection.

Figure 2: Artefacts with labels as displayed in the ROM's Africa, Americas, and the Asian Pacific gallery.

of the twentieth century. The assemblage, held together with animal glue, was slipped in clay to provide a uniform appearance. When Constantine Rickards gave pictures of his collection to Currelly, HM 1953 sat with other urns on shelves in his home. We will explore Rickards's motives later in this book (Did he intend to dupe the Royal Ontario Museum? Was he selling it as a composite piece?). In this chapter, we set the stage for telling HM 1953's particular story by exploring our preconceptions when examining museum objects.

Probing our often unconscious feelings toward objects leads us into the world of metaphysics, the branch of philosophy concerned with the fundamental nature of reality and being. Why do we classify certain objects as "real" and what are the criteria through which we justify this assertion? Answering these questions brings us way back to Aristotle's idea of essentialism and its relation to the categorization of things. Aristotle might seem a world away from objects like HM 1953, but museums like the ROM were built on essentialism. And although essentialism still frames how we view collections, late-twentieth-century constructivist approaches are now encouraging us to move beyond assertions of authenticity to better appreciate the rich histories of composite objects like urn HM 1953.

Essentialism and the Making of Encyclopaedic Museums

In Book II of *Physics*, Aristotle asks what makes a horse a horse and a man a man. He answers this question by asserting that horses, humans, and all other entities are different because certain properties make them one kind of thing or another. For Aristotle, all objects have accidental and essential properties. On the one hand, accidental properties are incidental; they define an individual example but can vary widely across many examples of a particular kind of thing. One horse, for example, can be old with brown hair while another is young with white hair, but they are both horses. Essential properties, on the other hand, are the kernel of sameness that can be found across an entire class of objects. In this case, the "horseness" that makes a horse what it is. For Aristotle, close analysis can reveal the essence of all objects.

Aristotle's strict essentialism is a heuristic device, creating a fixity and homogeneity of meaning that may have exceeded his own beliefs (Sklar 2002, 1). His philosophy as described is nonetheless critical to understanding the creation of encyclopaedic museums. As exotic objects began arriving in Europe by the mid-sixteenth century, elites put together rooms called "cabinets of curiosities" that featured a seeming hodgepodge of items ranging from trepanated skulls to coral, peacock feathers, and Javanese pots (Impey and MacGregor 2001; Figure 1.3). The collections celebrated radical difference—the Germans called them *Wunderkammer* or "wonder-inspiring cabinets"—displaying items that were not so much ordered but othered (Mullaney 1983, 40). The essences of the various curios were not yet defined.

This sense of wonder ran counter to the spirit of the Enlightenment, a philosophical movement born in the mid-eighteenth century that sought to replace faith with reason and despotism with natural law (Jacob 2000). In the realm of science, this meant making sense of the exotic. Carl Linnaeus (1741), for example, created an expansive taxonomy for the world's minerals, plants, animals, and humans. By classifying, ranking, and ordering, he created distinct *things* that were comprehensible within a larger system (Figure 1.4). Linnaeus thus distinguished between accidental and essential properties for the purpose of separating a horse from a camel or zebra. The search for order extended into culture—a concept to be more fully developed during the subsequent Romantic era (Simpson 1993)—as philosophers divided groups into stages of development associated with particular customs and tool sets (e.g., Condorcet 1933 [1795]; Rousseau 2007 [1755]; Turgot 1973 [1750]).

Cabinets of curiosities were thrown open to the public at the end of the seventeenth century to speed the spread of reason, and the exotic was essentialized through classification, labelling, and display (Bennett 1995; Hetherington 1999). For objects like coral, this meant that each piece was classified according to family, genus, and species. Pots and stone tools, by contrast, were seen as object lessons that provided unvarnished facts about the lives and mental capacities of other groups (Tythacott 2011, 133). These objects

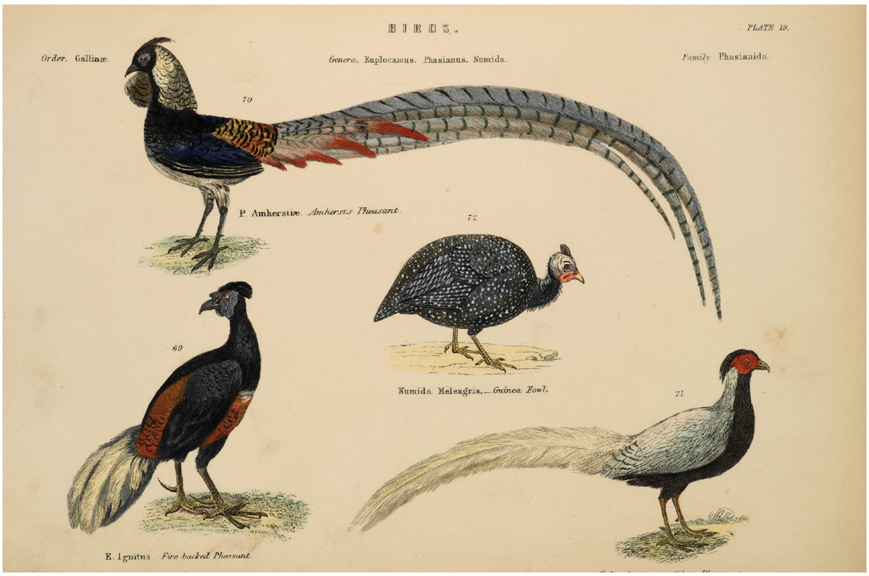


Figure 3: The frontispiece of Levinus Vincent's 1719 catalogue for his Cabinet of Curiosities.

Figure 4: Depiction of Euplocamus, a genus of pheasants subsequently subsumed under Lophura, in Plate 19 of an 1877 volume produced for the Museum of Natural History by Sir John Richardson and his colleagues.

could then be used to illustrate and rank the world's cultural diversity according to Enlightenment principles (Abt 2006, 123).

When a clear link was made, an object could forever stand for a culture because the essence of that culture remained fixed within an assemblage of objects. A Korowai initiation mask from New Guinea remained a Korowai initiation mask from New Guinea no matter where it was hung or how it was altered. Adding a few more objects alongside the mask gave you the Korowai in full. The most "authentic" cultural objects were unambiguous and could be easily classified into a recognized category like "Inuit," "harpoon," or "parka"—a thing, after all, could only have a single essence linked to a particular group. The role of conservators and curators was to ensure that only genuine, representative objects were put on display (Jones 2010, 188).

As nation-states took their modern form at the beginning of the nineteenth century, many of these Enlightenment-era collections were absorbed into private and state-sponsored encyclopaedic museums that sought to encapsulate the known world (Figure 1.5). Many of these museums were organized, at times explicitly, around a narrative of progress that marched from savagery toward government-run societies like their own that were seen as rational, secular, technologically advanced, and civilized (see Colonialism, Racism, and the Making of the Modern Museum). Although this narrative eventually collapsed under the weight of world wars, colonial fragmentation, and global capitalism, museums like the ROM are still routinely seen as housing authentic objects, each containing an essence linked to far-off places and bygone ages (Kingston 1999, 342).

Ways of life have changed rapidly in growing cities like Toronto, London, and Berlin. For many museum visitors today, it remains comforting to see "real things" from groups seemingly untouched by the many disruptions of modernity (Trant 1998). Museums still trade on this authenticity (Phillips 1997). Composite objects such as HM 1953 therefore remain largely unwelcome in galleries because they are not seen as "true" representations of the cultures under study. Yet the long-standing, rigid boundaries between "real" and "fake" museum objects are eroding, thanks in part to a group of French philosophers who began a fierce attack on essentialism in the late 1960s.

Post-structuralism and the Socially Constructed Object

On October 21, 1966, the French philosopher Jacques Derrida gave a lecture at a structuralism conference at Johns Hopkins University (Macksey and Donato 1970, xv). Structuralism has its basis in essentialism in the sense that its practitioners seek to uncover a society's "deep grammar"—the core structure that unconsciously unites seemingly disparate behaviours like cooking practices and marriage patterns (e.g., Levi-Strauss 1964). Derrida had come to Baltimore in order to challenge structuralism, and his lecture entitled "Structure, Sign, and Play in the Discourse of the Human Sciences" argued that there was no underlying deep grammar to social interactions—no firm ground upon which to build our reality (1967).

Figure 5: The late nineteenth century Assyrian Gallery at the British Museum—most items were obtained in Austen Henry Layard's 1845 excavations of Nineveh (postcard of engraving by Percy William Justyne).

COLONIALISM, RACISM, AND THE MAKING OF THE MODERN MUSEUM

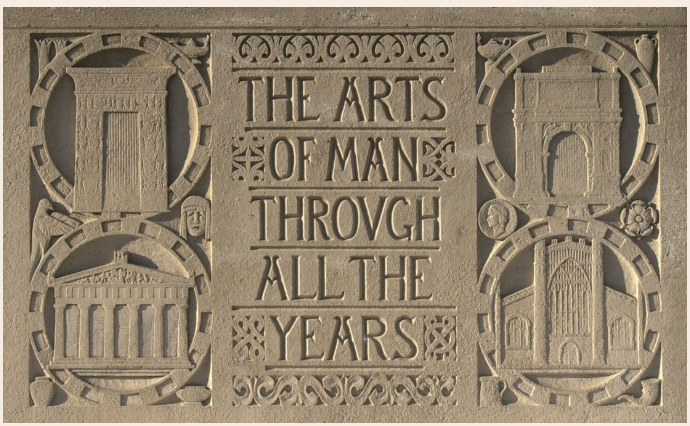
By the late nineteenth century, much of the world had been carved up into colonies by Europe and the United States. The period was one of unprecedented growth for Western museums, as millions of objects made their way from colonial holdings abroad into the monumental edifices of museums often designed in a neoclassical style that featured columns and porticos (Prior 2002, 49). After being accessioned into a symbol of the height of civilization, the imported items were classified, interpreted, labelled, and, on rare occasions, displayed (Peers and Brown 2003, 1).

The ethnographic and archaeological items brought into Western museums were usually organized following evolutionary schema that varyingly combined Enlightenment concepts of the stages of cultural development (Morgan 1963 [1877])—savagery, barbarism, and civilization—with an adaptation of Darwin's theory of evolution (1859) that argued that races developed at different rates because of biological differences. These evolutionary sequences were written into the labels, and, more generally, structured into the layout of the galleries (Bennett 2006, 278-279). Most museums were organized by geography, with collections grouped into culture areas. In many cases, one moved up the ladder of progress with objects created by those deemed as savages relegated to the basement.

A second way of organizing museum collections was typological, a system where objects of the same type were displayed together irrespective of their cultural origins. This later system was well suited to the creation of racial types that could be linked to

stages of technological and cognitive development. Louise Tythacott, for example, has detailed how racial typologies were used in the creation of the Melanian, Mongloian, and Caucasian galleries at the Liverpool Museum in 1901 (2011). These racial divisions were based on skin tone—black, yellow, and white—and each gallery was located on a different floor with distinct lighting, labelling, and imagery. A cacophony of photographs, maps, and objects greeted the visitor who ventured into the basement Melanian (black) gallery, while the airy, colonnaded main hall featured Caucasian (white) objects that were treated more as art objects to be contemplated rather then explained. Only the Caucasian gallery was organized to emphasize change over time. Although an extreme example of racial typology, the Liverpool museum was not alone: it sent 43 enlarged busts of idealized Melanian, Mongloian, and Caucasian people to the British Museum.

The Royal Ontario Museum was conceived near the end of the colonial rush that had filled the collections of older institutions like the Liverpool Museum (Mackenzie 2009, 56-57).By then, the flood of objects had paradoxically destabilized the very classificatory schemes that they were intended to support.Currelly thus went to Mexico to find pieces of technological and artistic virtuosity from Pre-Columbian cultures that had been widely dismissed as uncivilized just a few decades earlier.Yet, the director and his colleagues were very much people of their time. The ROM sought to bring all of humanity under one roof—a desire inscribed on the entrance to the building (see Box 1.1)—and was fully committed to the era's classificatory mission to divide and rank humanity into stages of progressive cultural development (Francis 1998). Our initial organization, layout, and displays of Canadian First Peoples and other groups thus reflected the paternalistic, racist principles of the day.



Box 1.1 Engraving welcoming visitors into the original entrance of the ROM

For Derrida, nothing is "real" because the differences that we perceive between things are cultural constructions. Where Aristotle believed that a horse was a horse because of its essential horseness, Derrida suggests a horse is a horse only because we say so. He argued that a change in how we categorize "horse"—perhaps to now define the term based on a particular color or a sound—would result in a whole different group of things categorized under the signifier of "horse." This was a radical, nihilistic proposal. If everything is a construction, then all the meanings that we assign are arbitrary. However, the critical point made by Derrida and other post-structural theorists is that meaning does not feel arbitrary because worldviews are often fixed for centuries.

The way we think is widely shared, non-discursive, and largely unconscious (e.g., Bourdieu 1977; Lyotard 1984). The meaning of "horse" or "table" might be a social construction, but anyone that routinely switched the terms would be seen as crazy. Derrida's contemporary, Michel Foucault, spent much of his career looking at how different systems of knowledge became deeply entrenched and the historical ruptures that led to sweeping changes in how we categorize things (1988 [1965], 1990 [1976], 1995[1975]). In *Discipline and Punish*, for example, Foucault looks at how the public spectacle of torture yielded to a regimen of secluded prisons in the mid-eighteenth century. Objects, as well as categories of individuals, were redefined within a new system of knowledge based on the idea of discipline over the mind and body.

More-recent scholarship emphasizes that objects are not passive agents in the social construction of meaning (Latour 1996 (1993); Ingold 2000). When we come to terms with something, we engage it with our senses. All objects have "affordances" that encourage certain interpretations and discourage others (Knappett 2004, 46). The meanings imposed on a long wooden pole, for example, vary widely based on cultural context, but one's interpretation of the pole is nonetheless constrained by the form, feel, and durability of the material from which it is made. To return to our earlier example, this new scholarship agrees with Derrida (and Foucault) in suggesting that "horse" is a social construction, but stresses that observed characteristics make it far easier for us to lump zebras and horses into a single category rather then water and horses.

The work of many post-structural scholars is anathema to the centuries-old mission of museums. If the meaning of an object rests in its relationship to external observers, then the objects that are put on display do not have an essence as Aristotle argued (Holtorf 2005). The "Inuit harpoon" under glass at the ROM had certain meanings to those who made it at home and thrust it into a seal. That object was then taken from that context to be archived, selected, and finally displayed on a shelf to signify the works of an "arctic culture"—an often timeless, bounded social construction that may be quite foreign to the individuals who first created and used the item (Pearce 1992, 5–6). The "Inuit harpoon" is irrevocably transformed during the long process of acquisition, curation, and exhibition, receiving its air quotes as it becomes a museum object (Clifford 1988; Errington 1998).

The items on display in museums influence our interpretations—they have affordances—but their meaning is (re)made at the moment of visitor engagement (Dudley 2010, 6–7; Figure 1.6). Derrida might impishly label everything at the ROM from a dinosaur bone to a birchbark canoe as simply a "museum object" and to a significant degree this is true. Once removed from the original contexts that gave them meaning and placed under glass, objects become "fakes" for post-structuralists in the sense that we no longer understand them as their makers did; rather, they become a product of our contemporary imagination. In a world of ever-shifting meanings, authenticity is no longer linked solely to essence, but can be achieved through intent, effort, and attention to detail (Holtrof and Schadla-Hall 1999; Lowenthal 1985). A painstakingly made reproduction can perform at least the same discursive work as an original, and indeed our senses seem to take in both kinds of objects in a similar matter (Saunderson et al. 2010). Following this logic, reproduction and original should have equal value.

Yet most of us are still a bit disappointed when we discover that an object is a replica. The plaster bones of a lunging *Tyrannosaurus rex* thrill, as does an exact facsimile of the *Mona Lisa*. But we hesitate to call them *real*. This hesitance likely stems from the enduring influence of essentialism: we think some*thing* special resides inside centuries-old objects that can put us in touch with past worlds (Wingfield 2010; Leadbeater 2015). I suggest we also feel this way also because replicas have a shorter story to tell. Many of the archaeological objects displayed in museums have existed for thousands of years or come from hundreds of kilometres away. They may have been physically transformed in dozens of ways, and were often employed in vastly different social contexts (Schiffer 1976).

Even if we concede that meaning is ultimately constructed at the moment of engagement, we can wind back the clock through careful research, tracking the "social life of things" to determine how an object's meaning has been constructed, ruptured, and reconstructed over time (Appadurai 1986). A spearhead, once broken, is discarded as trash, for example, only to become an artefact when it is dug up and displayed thirteen thousand years later as an exemplar of the Clovis tradition. The post-structuralism of Derrida has often been used to draw our focus to the end of the spear's biography, while Aristotle's essentialism takes us back to its origins. Composite objects like HM 1953 tend to emphasize the middle of this biography—the moment of assembly, when worlds of meanings meet—and remind us of the value of carefully tracing the often convoluted paths that bring museum collections into being.

Labelling HM 1953

Selecting and labelling museum collections for display is a fraught process (Longair 2015). In so doing, the curator puts objects in their place with a few bullet points. A lucky few get an additional 60-word "extended" label to provide additional context. The words we choose will fail to do justice to the pieces, both in the sense of explaining what we think the objects are and in how others

Figure 6: Visitors engaging with a mummy and sarcophagus in the ROM's Egyptian gallery.

might view them (Janes 2009, 160–61). Leaving items without labels, however, seems more ill-advised. Curators implicitly "label" objects simply in how we choose to put them on display (Bennett 2006), and, more importantly, visitors usually *want* information about these pieces, even if they disagree with our interpretations.

The labels for archaeological objects at the ROM and most other institutions continue to describe objects as they were first used. This is a result of enduring essentialism in the curatorial ranks, but perhaps more so of expediency—with few words available, we tell visitors the story that we think they most want to hear (noting that visitor expectations for the label are also often a product of essentialism). An object largely untouched since it was first manufactured is most suited to this kind of labelling. The meaning ascribed to a statue made in fourth-century BCE Athens may have gone through much iteration, and the statue itself may have endured many episodes of restoration. We can nonetheless provide a label describing the origins of the piece and its first use. Labelling a composite piece is more complicated, requiring us to understand how it was put together over time.

This book is our 75,000-word "extended" label for HM 1953, a Zapotec urn that was created three times: first, in the Zapotec State, second, during the collecting frenzy of the early twentieth-century Mexico, and finally in the storerooms of the Royal Ontario Museum. Some readers will come to this volume

with an understanding of Zapotec social organization; others will be familiar with the science behind thermoluminescence and ceramic petrography. Our intention is to tell the urn's story broadly, situating the object not only within its varying historical context but also within a general understanding of the different analytical techniques that were brought to bear on it.

For decades, HM 1953 stood among 120 other "Zapotec urns" thought to have been made in Oaxaca in the first millennium CE. Dozens of these previously "real" objects now sit in isolation after thermoluminescence dating determined that at least a portion of each was of recent manufacture. These composite or forged urns languish because they do not do the work that curators intend them to do—they are not "Zapotec" enough to perform as "Zapotec" in our display cases. Nonetheless, such "fake" vessels often have a story to tell that is in many ways richer than that of the "real" Zapotec urn currently on display in our gallery.

Our archival and material study of HM 1953—as well as of one vessel from Berlin and another from Oaxaca—reconstructs the life of this one object in our collection. The story of HM 1953 begins in the first millennium CE, in the Zapotec State located in what is today southern Mexico. The next chapter gives a sense of what life was like during this era, focusing in particular on the pervasive influence of Zapotec cosmology. Chapter 3 looks at the pivotal roles played by funerary urns, before Chapter 4 hones in on archival and historical evidence for HM 1953's discovery, reconstruction, and arrival into the ROM's collections. Subsequent chapters describe our intensive material analysis of the urn itself, beginning with a discussion of the initial surface examinations that in many ways spurred us to learn more about how HM 1953 came into being. For years, HM 1953 was labelled a "fake" undeserving of further study. This book reveals the knowledge obscured by this assertion. Perhaps it is time to take the post-structuralists' lesson to heart: what is "real" and "fake" is less important than what we can learn from an object through careful analysis.

References Cited

Aristotle. 2008. *Physics*. Translated by Robin Waterfield. Oxford: Oxford University Press.

Abt, Jeffery. 2006. "The Origins of Public Museums." In *A Companion to Museum Studies*, edited by Sharon Macdonald, 115–34. Malden: Blackwell.

Appadurai, Arjun, ed. 1986. *The Social Life of Things: Commodities in Cultural Perspective*. New York: Cambridge University Press.

Bennett, Tony. 1995. *Birth of the Museum: History, Theory, Politics*. New York: Routledge.

———. 2006. "Civic Seeing: Museums and

the Organization of Vision." In *A Companion to Museum Studies*, edited by Sharon Macdonald, 263–281. Malden: Blackwell.

Bourdieu, Pierre. 1977. *Outline of a Theory of Practice*. Translated by Richard Nice. New York: Cambridge University Press.

Brulotte, Ronda L. 2012. *Between Art and Artifact: Archaeological Replicas and Cultural Productions in Oaxaca, Mexico*. Austin: University of Texas Press.

Clifford, James. 1988. *The Predicament of Culture: Twentieth-Century Ethnography, Literature, and Art*. Cambridge: Harvard University Press.

Condorcet, Jean-Antoine-Nicolas de Caritat. 1933 [1795]. *Esquisse d'un tableau historique des progrès de l'esprit humain*. Paris: Boivin.

Currelly, Charles Trick. 1956. *I Brought the Ages Home*. Toronto: Ryerson Press.

Darwin, Charles. 1859. *On the Origins of Species by Means of Natural Selection*. London: John Murray.

Derrida, Jacques. 1967. *L'écriture et la différence*. Paris: Éditions du Seuil.

Dickson, Lovat. 1986. *The Museum Makers: The Story of the Royal Ontario Museum*. Toronto: University of Toronto Press.

Dudley, Sandra H. 2010. "Museum Materialities: Objects, Sense, and Feeling." In *Museum Materialities: Objects, Engagement, Interpretation*, edited by Sandra H. Dudley, 1–18. New York: Routledge.

Errington, Shelly. 1998. *The Death of Authentic Primitive Art and Other Tales of Progress*. Berkeley: University of California Press.

Foucault, Michel. 1988 (1965). *Madness and Civilization: A History of Insanity in the Age of Reason*. Translated by Richard Howard. New York: Vintage Books.

———. 1990 (1976). *The History of Sexuality*. Translated by Robert Hurley. New York: Vintage Books.

———. 1995 (1975). *Discipline and Punish: The Birth of the Prison*. Translated by Alan Sheridan. New York: Vintage Books.

Francis, Mark. 1998. "The 'Civilizing' of Indigenous People in Nineteenth Century Canada." *Journal of World History* 9 (1): 51–87.

Geurds, Alexander, and Laura Van Broekhoven, eds. 2013. *Creating Authenticity: Authentication Processes in Ethnographic Museums*. Leiden: Sidestone Press.

Hermens, Erma, and Tina Fiske, eds. 2009. *Art Conservation and Authenticities: Material Concept, Context*. London: Archetype.

Hetherington, Kevin. 1999. From Blindness to Blindness: Museums, Heterogeneity, and the Subject. In *Actor-Network Theory and After*, edited by John Law and John Hassard, 51-73. Oxford: Blackwell.

Holtorf, Cornelius. 2005. *From Stonehenge to Las Vegas: Archaeology as Popular Culture*. New York: Altamira Press.

Holtrof, Cornelius, and Tim Schadla-Hall. 2005. "Age as Artefact: On Archaeological Authenticity." *European Journal of Archaeology* 2 (2): 229–47.

Impey, Oliver, and Arthur MacGregor. 2001. *The Origins of Museums: The Cabinet of Curiosities in Sixteenth and Seventeenth Century Europe*. London: House of Stratus.

Ingold, Tim. 2000. *The Perception of the Environment: Essays on Livelihood, Dwelling, and Skill*. New York: Routledge.

Jacob, Margaret C. 2000. *The Enlightenment: A Brief History with Documents*. Boston: Bedford/St. Martin's.

Janes, Robert R. 2009. *Museums in a Troubled World: Renewal, Irrelevance, or Collapse*. New York: Routledge.

Jones, Mark, ed. 1992. *Why Fakes Matter: Essays on Problems of Authenticity*. London: British Museum Press.

Jones, Siân. 2010. "Negotiating Authentic Objects and Authentic Selves: Beyond the Deconstruction of Authenticity." *Journal of Material Culture* 15 (2): 181–203.

Kelker, Nancy L., and Karen O. Bruhns. 2010. *Faking Ancient Mesoamerica*. Walnut Creek: Left Coast Press.

Kingston, Sean. 1999. "The Essential Attitude: Authenticity in Primitive Art, Ethnographic Performances, and Museums." *Journal of Material Culture* 4 (3): 338–51.

Knappett, Carl. 2004. "The Affordances of Things: A Post-Gibsonian Perspective on the Relationality of Mind and Matter." In *Rethinking Materiality: The Engagment of Mind with the Material World*, edited by Elizabeth DeMarrais, Chris Gosden, and Colin Renfrew, 43–52. Cambridge: McDonald Institute of Archaeology.

Latour, Bruno. 1996 (1993). *Aramis or the Love of Technology*. Translated by Catherine Porter. Cambridge: Cambridge University Press.

Leadbetter, Chris. 2015. "Lascaux Cave and the Rise of the Fake Attraction." *The Telegraph*, September 12. http://www.telegraph.co.uk/travel/destinations/europe/france/aquitaine/articles/Lascaux-Cave-and-the-rise-of-the-fake-attraction/

Levi-Strauss, Claude. 1964. *The Raw and the Cooked*. Chicago: University of Chicago Press.

Longair, Sarah. 2015. "Cultures of Curating: The Limits of Authority." *Museum Histories Journal* 8 (1): 1–7.

Lowenthal, David. 1985. *The Past Is a Foreign Country*. Cambridge: Cambridge University Press.

Lyotard, Jean-François. *1984. The Postmodern Condition: A Report on Knowledge*. Translated by Geoff Bennington and Brian Massumi. Minneapolis: University of Minnesota Press.

MacKenzie, John M. 2009. *Museums and Empire: Natural History, Human Cultures, and Colonial Identities*. New York: Manchester University Press.

Macksey, Richard, and Eugenio Donato. 1970. "Preface." In *The Structuralist Controversy: The Languages of Criticism and the Sciences of Man*, edited by Richard Macksey and Eugenio Donato, xv–xix. Baltimore: Johns Hopkins University Press.

Morgan, Lewis Henry. 1963 [1877]. *Ancient Society*. New York: Meridan Books.

Mullaney, Steven. 1983. "Strange Things, Gross Terms, Curious Customs: The Rehearsal of Cultures in the Late Renaissance." *Representations* 3: 40–67.

Pearce, Susan M. 1992. *Museum Objects and Collections: A Cultural Study*. London: Leicester University Press.

Peers, Laura, and Alison Brown. 2003. "Introduction." In *Museums and Source Communities: A Routledge Reader*, edited by Laura Peers and Alison Brown, 1–16. New York: Routledge.

Phillips, David. 1997. *Exhibiting Authenticity*. New York: Manchester University Press.

Prior, Nick. 2002. *Museums and Modernity: Art Galleries and the Making of Modern Culture*. Oxford: Berg.

Richardson, Sir John, William S. Dallas, and T. Spencer Cobbold. 1877. *The Museum of Natural History: being a popular account of the structure, habits, and classification of the various departments of the animal kingdom: quadrupeds, birds, reptiles, fishes, shells, and insects,*

including the insects destructive to agriculture. New York: James S. Virtus.

Rousseau, Jean Jacques. 2007 [1755]. *A Discourse Upon the Origin and the Foundation of the Inequality among Mankind*. Minneapolis: Filiquarian Publishing.

Saunderson, Helen, Alice Cruickshank, and Eugene McSorley. 2010. “The Eyes Have It: Eye Movements and the Debatable Differences between Original Objects and Reproductions.” In *Museum Materialities: Objects, Engagement, Interpretation*, edited by Sandra H. Dudley, 89–98. New York: Routledge.

Scheidemann, Christian. 2009. “Authenticity: How to Get There?” In *Art Conservation and Authenticities: Material Concept, Context*, edited by Erma Hermens and Tina Fiske, 3–12. London: Archetype.

Schiffer, Michael B. 1976. *Behavioral Archaeology*. New York: Academic Press.

Sellen, Adam T. 2004. “The Face That Launched a Thousand Fakes?” *Rotunda: The Magazine of the Royal Ontario Museum* 36 (3): 32–39.

Sklar, Lawrence. 2002. “Physics, Metaphysics, and Method in Newton’s Dynamics.” In *The Blackwell Guide to Metaphysics*, edited by Richard M. Gale, 1–18. Malden: Blackwell.

Simpson, David. 1993. *Romanticism, Nationalism, and the Revolt against Theory.* Chicago: University of Chicago Press.

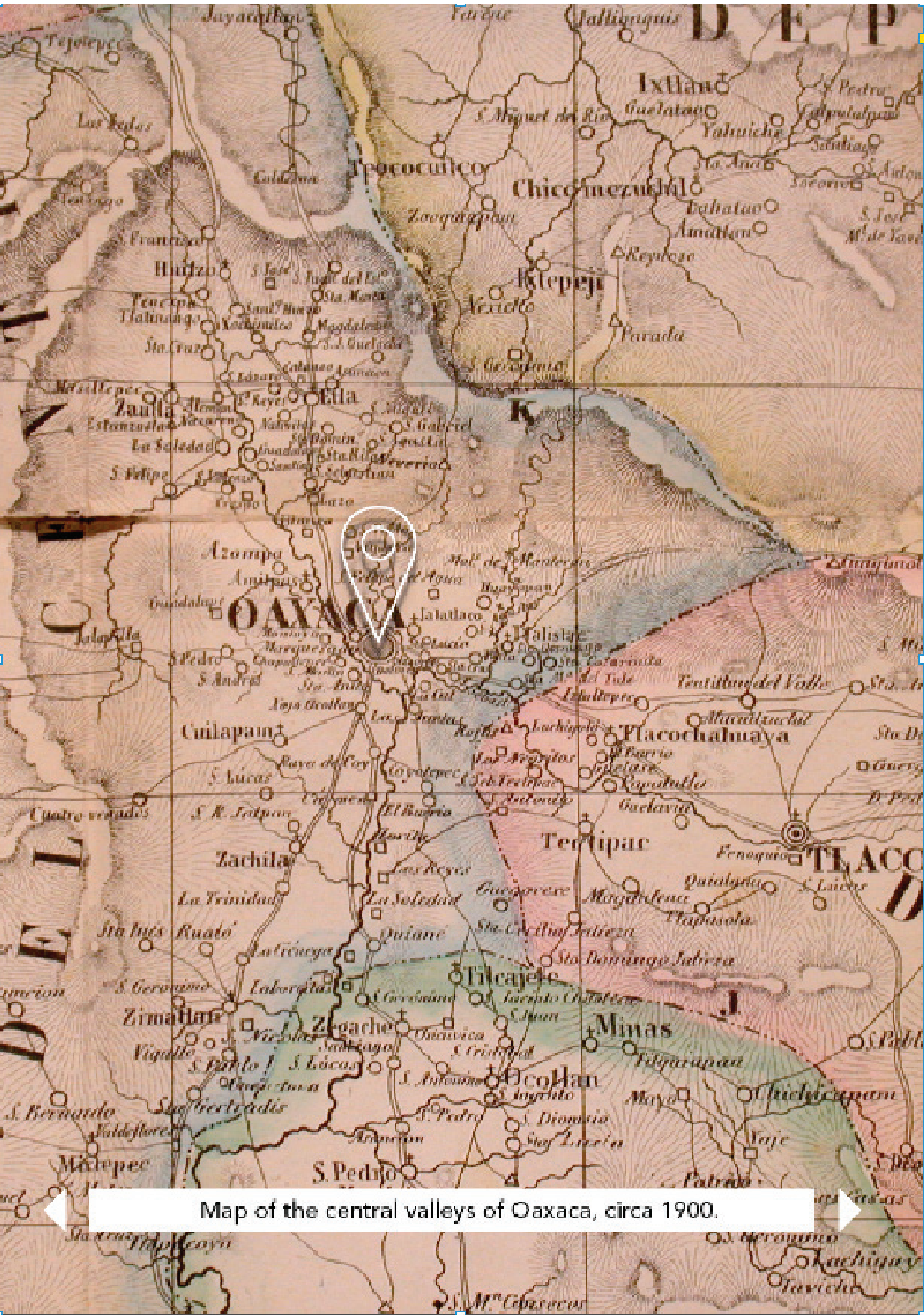
Trant, Jennifer. 1999. “When All You’ve Got is ‘The Real Thing’: Museums and Authenticity in the Networked World.” *Archives and Informatics* 12: 107–125.

Turgot, Jacques. 1973 (1750). A Philosophical Review of the Successive Advances of the Human Mind. In *Turgot on Progress, Sociology and Economics*, edited by Ronald L. Meeks, 41–59. New York: Cambridge University Press.

Tythacott, Louise. 2011. “Race on Display: ‘The Melanian’, ‘Mongolian’, and ‘Caucasian’ Galleries at Liverpool Museum (1896–1929).” *Early Popular Visual Culture* 9 (2): 131–46.

Vincent, Levinus. 1719. *Elenchus tabularum, pinacothecarum, atque nonnullorum cimeliorum, in gazophylacio Levini Vincent*. Haarlem: Sumptibus auctoris.

Wingfield, Christopher. 2010. “Touching the Buddha: Encounters with a Charismatic Object” In *Museum Materialities: Objects, Engagement, Interpretation*, edited by Sandra H. Dudley, 53–70. New York: Routledge.



Map of the central valleys of Oaxaca, circa 1900.

CHAPTER 2

Ritual and Society in Ancient Central Oaxaca (350–850 CE)

JAVIER URCID / BRANDEIS UNIVERSITY

The peoples who inhabited the Central Valleys of Oaxaca between the fourth and ninth centuries CE were the inheritors of a long cultural tradition whose origins were, by then, most likely mythologized. Over the course of millennia, their predecessors had contributed to major societal and cultural transformations that typified the Mesoamerican world of the time. Like several other coeval native peoples of Middle America, their remote forbearers had established symbiotic relationships with key cultivars since at least the sixth millennium BCE, a process that eventually led their descendants to commit irreversibly to an agricultural economy (Joyce 2010; Marcus and Flannery 1996). And just a few millennia before the Common Era, the descendants of those early agriculturalists had already experienced the long-term, unintended consequences of sedentism. Social inequality had been institutionalized and naturalized by deeply rooted sacred propositions, and regional forms of social organization had drawn people to establish, some 400 years BCE, a prime settlement that, with increased levels of political centralization, grew through time into a large urban center (Blanton 1978; Joyce 2000; Joyce and Winter 1996; Winter 2011).

This pristine city—now called Monte Albán (White Mountain) and whose original names are now forgotten—is perched atop a series of hills that rise some 400 metres from the surrounding alluvial plains. At its peak, it is estimated to have sprawled over seven square kilometres and to have had some 22,000 inhabitants. The relentless growth of this political capital was accompanied by a veritable demographic boom in the immediate hinterland (Blanton et al. 1999; Kowalewski 1990). This peripheral zone not only provided foodstuffs to the nascent city but spawned previously unknown degrees of occupational

specialization. Rulers bore the burden of governing and concealed or boasted their right to rule, while followers supplied goods and labour. Merchants sought distant and exotic raw material and commodities, while commoners exchanged basic, everyday resources and services. Crafters skillfully produced aesthetically charged objects in different materials, just as diviners invoked oracles to foretell births, marriages, witchcraft, and death. Architects and masons busied themselves building and reshaping, again and again, the monumental core of the city, while astronomers set the stage for hierophanies and timekeepers who ordained the pace for ritual covenants. Religious specialists sacrificed humans and animals in return for divine favours. Scribes, meanwhile, invented a logosyllabic script under the patronage of the ruling elites and sought to selectively forget and only pass on what was deemed memorable (see First Writing in Oaxaca). While healers and midwives helped people cope during the most fragile stages of the human life cycle, warriors strove to accrue prestige on the battlefield and on the ballcourts.

While urbanization proceeded and the city's political and economic control became increasingly regional, social constituencies at Monte Albán struggled internally for political representation and power (Urcid 2011; Urcid and Joyce 2013). Meanwhile, the vast agrarian landscape in the surrounding valleys was dotted with large and small towns, countless villages, and handfuls of hamlets. Over time, as the need for arable land grew, people established or relocated some settlements on hills and piedmont zones with extensive residential terraces (Kowalewski and Finsten 1983; Feinman et al. 2002). By the ninth century CE, the population of the Central Valleys of Oaxaca is estimated to have been approximately 120,000, yielding a density of 56 persons per square kilometre (Kowalewski 1990; Figure 2.1). The balance of political and economic power between urban and rural elites was precarious: at times the city brought within its sphere of control and influence both nearby and distant settlements, thus increasing in power. On other occasions, the growing influence of rural elites, both in the near periphery and on the fringes of the city's political domain, beyond the Central Valleys, necessitated alternative arrangements with the capital, including marriage alliances, diplomatic accords, and patron–client relationships (Lind and Urcid 2010).

In a world characterized by an agricultural subsistence, marked social differences, and unequal access to political power, the core social units that facilitated economic production and biological reproduction were descent groups who traced their origin to real or fictitious apical ancestors. These descent groups, related by marriage and blood, included those who owned the means of production and those who provided labour and services, and together they coalesced into corporate groups that vied for wealth, prestige, and political clout. The recounting and recording of genealogies became, at least from the fourth century CE, a core institution through which claims to landed estates, labour, and key positions in the religious and political spheres were constantly negotiated. Although the trend was for members of these groups to trace descent

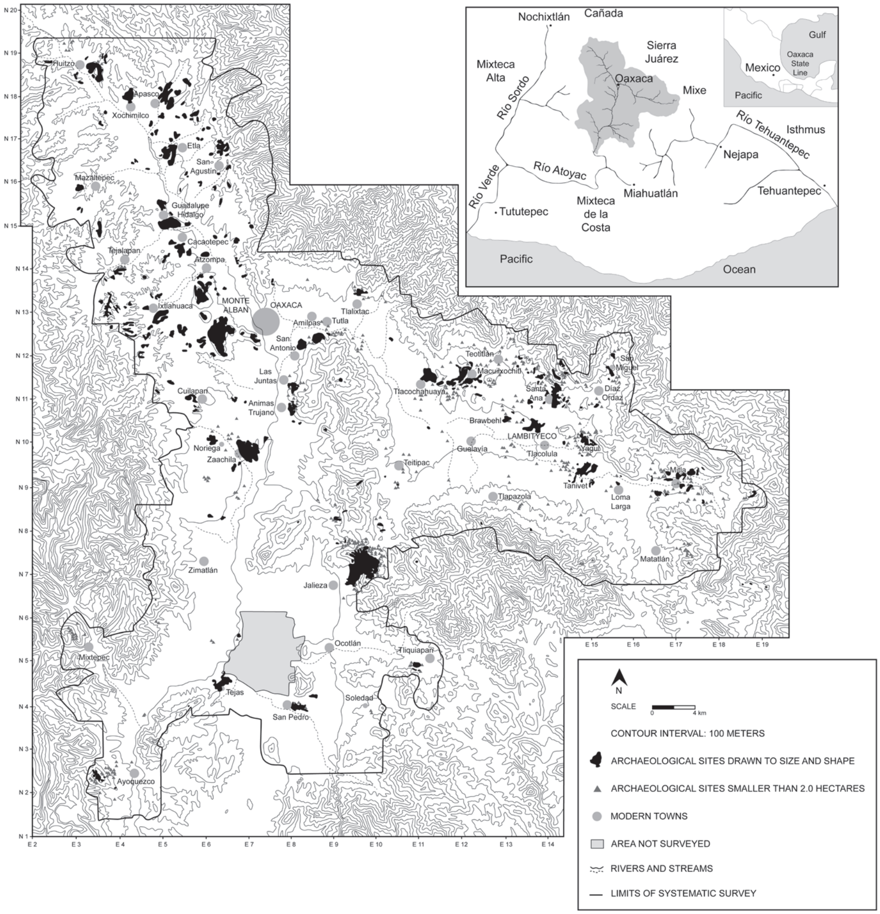


Figure 1: Settlements in the Central Valleys of Oaxaca during the seventh and ninth centuries CE (after Lind and Urcid 2010: 22).

FIRST WRITING IN OAXACA

The earliest scribal tradition in Oaxaca, probably invented circa the sixth century BCE, endured more than a millennium. Throughout that time, the script underwent significant changes, but also exhibited certain continuities and conservatism. By the ninth century CE, this form of communication had lost prestige and was superseded by novel graphic conventions that radically transformed the visual character of writing. The earlier writing system, which was used as an instrument of elite political action and as a technology to foster historical consciousness and social memory, relied on figurative narratives accompanied by short, formulaic texts with signs that mimicked the natural and human-made world. While in certain contexts the glyphs coded for words based on what they represented or by homophonic values, in some specific cases they seemingly prompted syllabic spellings (Box 1.1a).

Box 1.1a: The iconic nature of the signs in the script

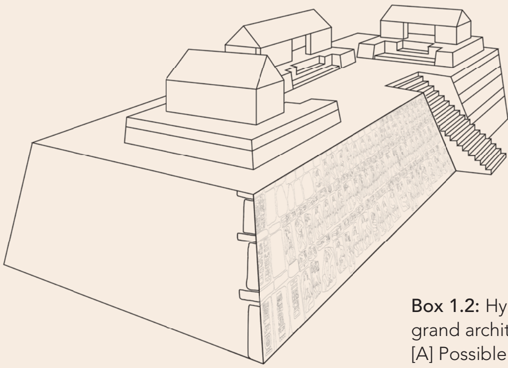
The display of image and text made the message accessible to people with varied levels of literacy: one could merely grasp semantically the outline or overall sketch of the message, or one could phonetically decode nuances and details in the inscriptions. The logophonic component of the script required an expandable and hence large inventory of glyphs, which in turn necessitated long and sustained training in the art of writing. This learning process was the exclusive purview of the top social echelons.

Scribes did not limit themselves, but strove to present their work in innovative ways. Sign forms, text layouts, and reading directions varied lavishly. The written surface became a canvas on which the collocation, size, sequence, orientation, and grouping of glyphs adhered to expected aesthetical ideals and yielded additional layers of meaning. Bark paper, cured deer hides, sheets of cloth, and wooden surfaces were likely common media for writing, but these have not been preserved. Traces of scribal practices have survived instead on stone, painted stucco, fired clay, shell, and both animal and human bones. The wide range of inscribed media evinces the variety of instruments to write: stone chisels and blades, brushes, and pointed sticks (Box 1.1b).

At Monte Albán and secondary centres, image and text embellished both public and private buildings, covering and wrapping around multiple surfaces such as lintels, jambs, columns, entablatures, corner stones, stelae, and even entire facades. Between 400 BCE and 200 CE, when inclusionary forms of governance prevailed in the Central Valleys, the semantic component of visual communication stressed communal participation, while the phonetic part draw attention to the deeds of overlords. As

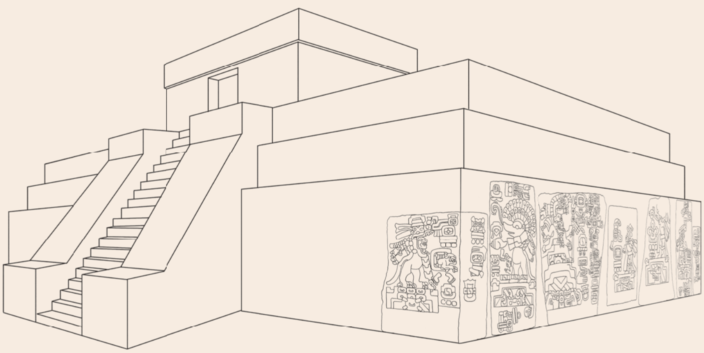
Box 1.1b: Varied inscribed media.

time went on and the ruling elites increasingly exerted more exclusionary forms of control, the inscribed narratives glorified rulers and highlighted their military successes aimed at securing or expanding Monte Albán's territorial claims (Box 1.2).



A

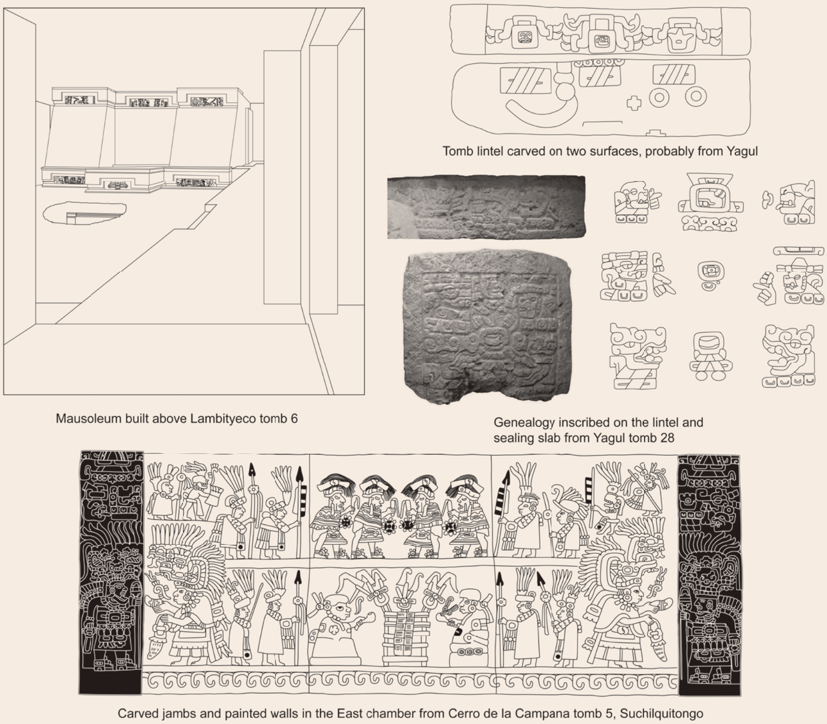
Box 1.2: Hypothetical reconstructions of grand architectural narratives at Monte Albán. [A] Possible configuration of Building L-sub (circa 300 BCE); [B] possible context of carved orthostats later reused to mark the corners of the South Platform (circa 600 CE).



B

Concomitantly, portable items bearing inscriptions circulated in both the public and the private domains. In noble and royal houses, fixed features related to the world of the ancestors bore inscribed genealogical records, naming trans-generational protagonists and their relationship to founding ancestors. At times, these reckonings were written amidst the representation of funerary processions, the display of mortuary bundles, and the gifts, offerings, and tribute presented to the founders. Thus, the lintels, jambs, entablatures, interior walls, sills of niches, roof slabs, and the stone blocks with which underground crypts where sealed became storyboards that

were read and prompted action each time the living re-opened a tomb to bury a person or to commemorate and conjure the ancestors (Box 1.3). In these vignettes, the ancestors are never represented as dead. Rather, they are shown as animating a temporally parallel world of the living. Writing in the domestic realm was a powerful way to legitimate social relations, disambiguate group memberships, and prove or contest both the tangible and intangible privileges of mortals.



Box 1.3: Genealogical reckonings and representation of royal obsequies in crypts built underneath high-ranking houses.

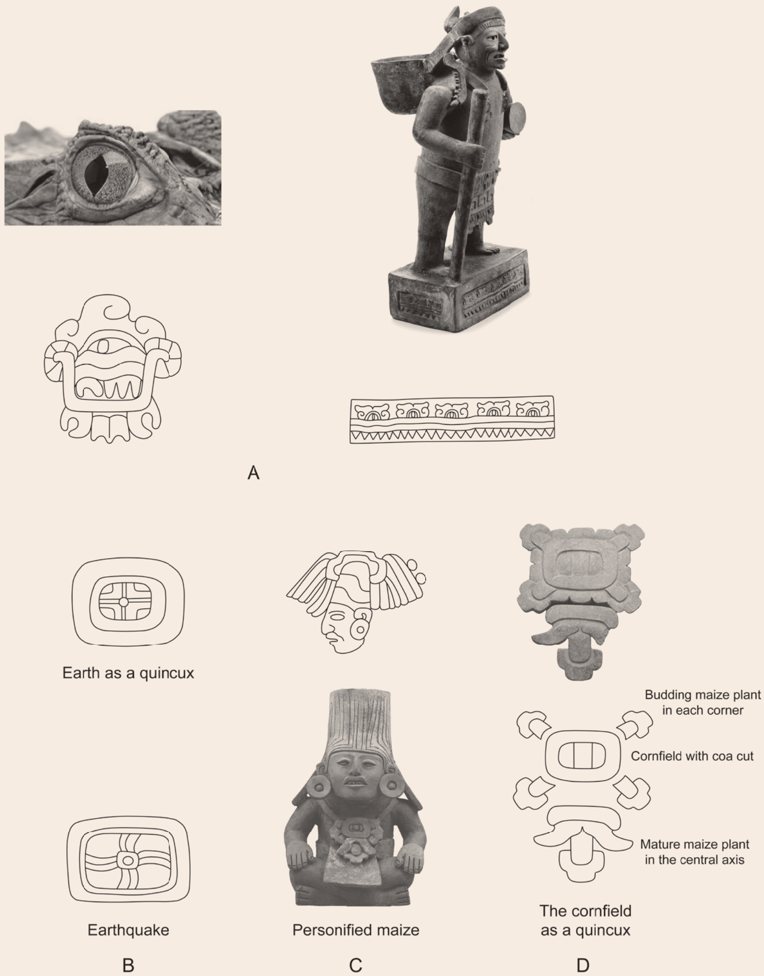
through the male line, several known instances of prominent and powerful women attests to the rule of cognatic affiliation, making it clear that at times corporate groups pursued the maternal or the paternal line in recognizing parentage depending on the prestige and wealth at stake (Urcid 2005).

Deeply ingrained in the fabric of daily life was the conception of a world symbolically parsed as a centre marked by four directions, a veritable quincunx where time, space, the body, the community, and the visible and invisible realms converged in a delicate balance that had to be propitiated and maintained through proper conduct (see A View of the World). A constant centering of the world through ritual and penitence, offerings and sacrifice, permeated the domestic and the public spheres, and implicated individuals, households, corporate groups, and communities (Winter 2002).

A VIEW OF THE WORLD

For the ancient inhabitants of central Oaxaca, as for other Amerindian peoples, the world was made up of layers: the earthly stratum of the living with the sky above and the underworld of ancestral beings below. Each realm was in turn divided into four quadrants and a centre, and what sustained the skies was five sacred trees grounded accordingly in the domain of the living. In using natural entities to create symbolic maps of these realms, the ancients left an indirect record of their worldview.

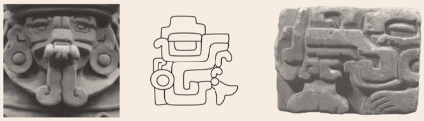
The earth was at times depicted as an alligator, and when that alligator reposed on water, the implication was that the abode of mortals floated over a primordial sea. The domain of the living was also represented as a square cartouche divided into four quadrants; the addition of a small circle in the centre turned this into a quincunx. By substituting curved strokes for the straight lines in the sign, scribes graphically conveyed the animated nature of Earth as made evident by trembles and quakes. The account of creation in which humans originated from maize is often represented by conflating persons with the corncob.The interdependence of people and maize caused maize to be viewed as sacred nourishment; the earth (a square cartouche) could thus be depicted with a cornfield at its centre and a budding maize plant in each corner (Sellen 2011). In such representations, the growth cycle of corn is shown along the central axis of the cartouche: in the centre is the “wound” that is opened



Box 2.1: [A] Symbolic representation of Earth as an alligator; [B-C-D] the animated nature of earth, maize, and the cornfield.

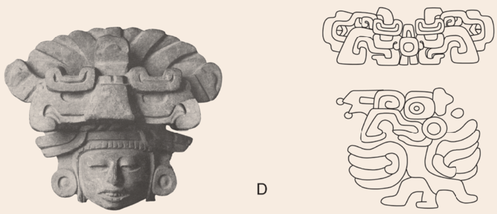
on earth by the digging stick in order to plant two or three seeds, and along the inferior border, in the inverted position, a mature corncob grows tall (Box 2.1). The relationship of people to maize led as well to a gendered, binary, and complementary principle: maize, agriculture, and sustenance were feminized, and the bat, hunting, and predation were masculinized. Elites and commoners took the serpent as the avatar of rain, and thus its personifications invariably wore a mask over the lower face (cheeks and mouth) with a bifid tongue.

A



B

C

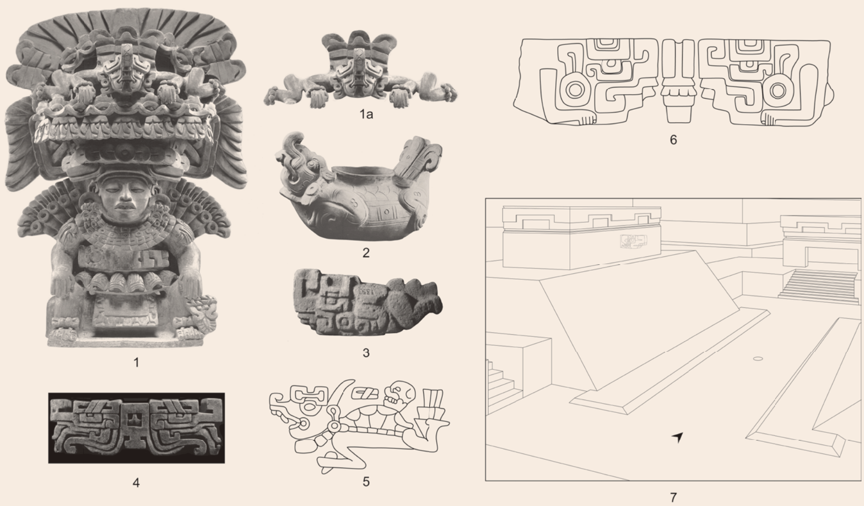


D

Box 2.2: [A] Engendering of Maize-agriculture as female and Bat-hunting as male; [B] the serpent as the avatar of rain; [C] jaguar imagery as marker of rulership; [D] the imagery of a bird with a broad beak as symbol of the Sun.

Overlords co-opted as a symbol of governance and aristocratic privilege the imagery of jaguars, and many of the known representations of rulers from Monte Albán and other lesser-ranking communities depict them as anthropomorphized felines. At times, the portentous act of human sacrifice is symbolized as a jaguar devouring a human heart, whose vitalized nature was rendered as three inward-looking scrolls. Ruling elites and nobles also identified themselves with the Sun, alluding to it by representations of a bird with a broad beak that in previous creations pretended to be as bright and radiant as the true Sun while being perched on one of the five sacred trees (Box 2.2).

Representations of alter egos hinted at the obscure underworld. Through shape shifting, persons with specialized knowledge attained ontological states that enabled them to address and communicate with the ancestors. In sharp contrast with later practices in the Central Valleys of Oaxaca (and the practices of close and distant neighbours), the imagery of skeletonized beings was seldom deployed, although a human skull served to name one of the days in the reckoning of time. Rather, what abounds in the imagery that alludes to the realm of ancestral spirits is a conflation of a turtle's carapace with a human being wearing the mask of a lizard. Always shown in a horizontal position, and as if floating (to convey its ability to fly), this composite creature has attached to the back of the carapace an appendage that may have been modelled on the striking, jagged lightning bolt. A swooping and luminous presence, this "Fire Serpent" mediated the layered domains of the world and was often the emblem of alterity for paramount rulers and of their role as sacrificers of animals and humans. As such, the "Fire Serpent" figured prominently as a marker in ballcourts throughout southwestern Mesoamerica and beyond, and served as a powerful symbol of political authority (Box 2.3).



Box 2.3: The imagery of the "Fire Serpent" to reference the ontological status of alterity needed to communicate with ancestral spirits.

Homes

This view of the world was both internalized through, and externalized by, the spatial configuration of houses. Despite variations dictated by the social rank of households and their corporate groups of affiliation, houses typically included a central open courtyard through which air and sunlight passed, surrounded by four to eight roofed and windowless rooms (Winter 1974; Figure 2.2). Depending on the occupants' wealth, these rooms were built with stone, mud-bricks, or wattle-and-daub, and the flooring of open spaces was stuccoed, paved with flagstones, or left as compacted earth. The four main rooms in a house were cardinally oriented and, in high-status households, had flat gravel roofs supported by wooden beams. The corner rooms had flat masonry roofs or were simply thatched. Some of the rooms were furnished with a large but shallow ceramic basin embedded in the centre of the floor, where burning coal was kept during nights and winters to warm interior spaces. The place for cooking was in the courtyard or often outside the house but within the household plot (Figure 2.3).

To drain excess rainfall from the open courtyard to the periphery of the house, houses had either a stone-lined shallow canal covered with slabs, or a composite drainpipe assembled from several conical ceramic cylinders 30 centimetres long. These drainages were of variable extension depending on the size of a house and the particular configuration of the terrain upon which they were built. It seems conceivable, at least in cases where the inhabitants did not have ready access to sources of water (as on the uppermost terraced slopes of Monte Albán), that rainfall flowing down roofs could have been collected and stored.

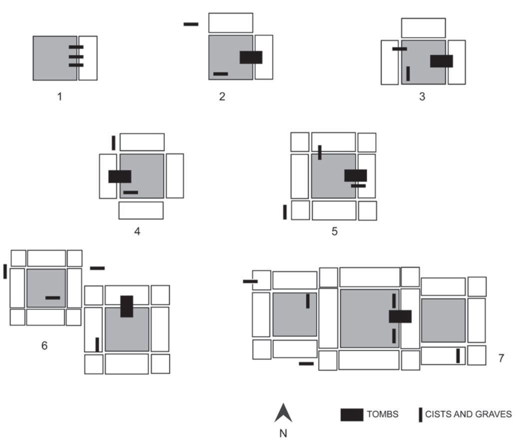


Figure 2: Variation in size and configuration of houses related to differences in social rank.

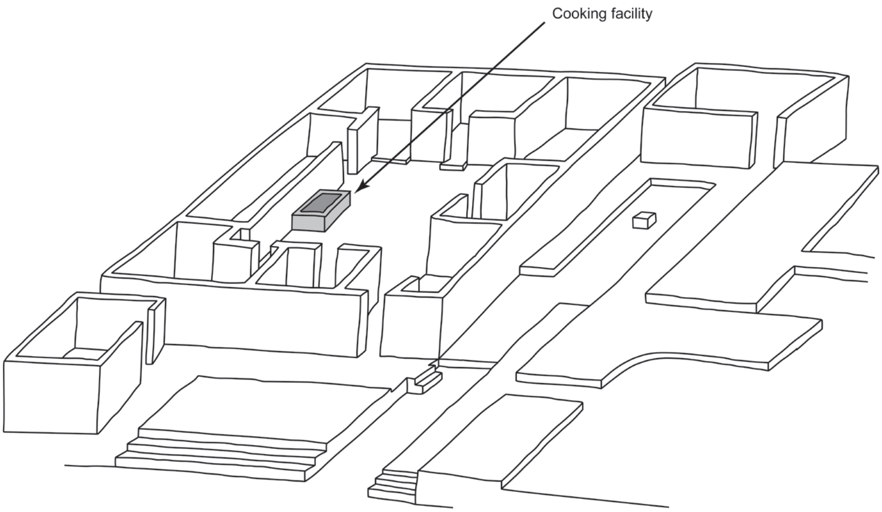
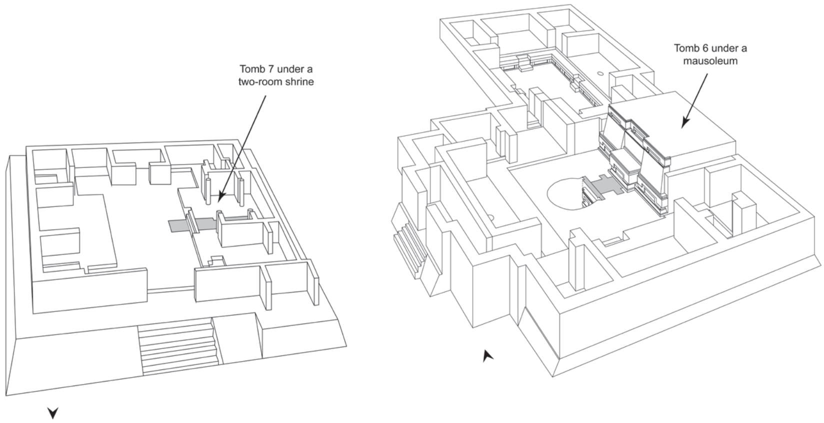


Figure 3: An elite house from the 2nd century BCE with a cooking facility in the courtyard (redrawn and modified from Spencer and Redmond 2004: 447).

Symbolism in Architecture and Daily Life

Through the habits of daily life, household members created and re-created a five-part ordered world, assigning particular symbolic values to practices carried out in the courtyard, in the rooms, and on the household plot. With few exceptions, it was common to allocate the east room of the house to memorialize the ancestors. This room was sometimes configured as a two-room shrine, like the places of worship in private or public buildings, or else was turned into a mausoleum embellished with inscribed genealogies (Figure 2.4). Directly underneath hallowed markers in this room lay the masonry tomb where many generations of heads of households were buried. Other members of the household, young and old, female and male, were interred in simple graves under the floor of the courtyard or of other rooms, or at times outside the house but within the bounds of the household plot.



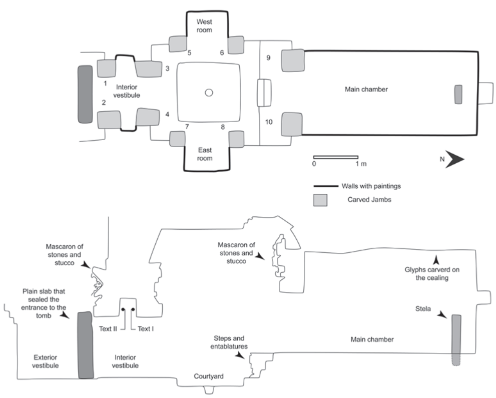


Figure 4: The houses of Monte Albán tomb 7 and Lambityeco tomb 6 showing variation in the orientation and configuration of ancestors' shrines.

Figure 5: Plan and profile views of tomb 5 from Cerro de la Campana, Suchilquitongo.

The eastern placement of shrines, mausoleums, and crypts symbolically links the human life cycle with the Sun's trajectory on the horizon, pairing death with the appearance of the sun, the shining of light and warmth, the beginning of new cycles, and with rebirth and renewal. The underground "houses of ancestors" were relatively easy to access by digging a hole in the courtyard and reaching, a few metres below the surface, the sealed entrance to the crypts. In the homes of the wealthy, the opening of a hole in the courtyard led to a set of masonry steps that descended into the tomb. Commonly, the architectural layout of the crypts replicated the fivefold cosmogram: tombs often included a main chamber delimited by a vestibule on one side or directly by the entrance, and by small recessed niches on the other three walls. In fact, the largest known tomb is a miniature underground house, with a central courtyard and four rooms around it (Figure 2.5). If houses were occupied over long periods, the crypts were enlarged or additional ones were built adjacent to earlier tombs.

These multigenerational ossuaries typically contain the remains of several individuals and the offerings that were left for them. The last person to have been buried in a tomb lays in anatomical position, while the skeletal remains of predecessors appear disarticulated, mixed, and piled up or pushed against the walls and corners, or in the niches. Offerings included personal items and objects of everyday life. At times, these were complemented by sacrificed quails dedicated as sustenance for the ancestors, and immolated puppies, construed as guides for the soul in its journey to a final resting place (Figure 2.6). Tombs were accessed not only to bury a newly deceased household head, but also to honour the ancestors at key death anniversaries, when skeletal remains were sprinkled with red cinnabar and objects in the offerings were repositioned, and even to retrieve specific bones for use as legitimating heirlooms.

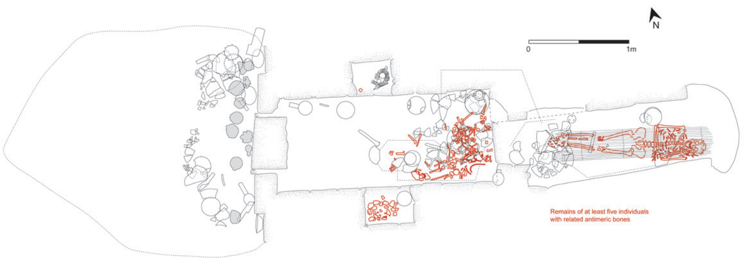


Figure 6 (a): Plan of Lambityeco tomb 6 showing the distribution of burials and offerings. (During its use, the tomb was enlarged by adding on the back a second chamber.)

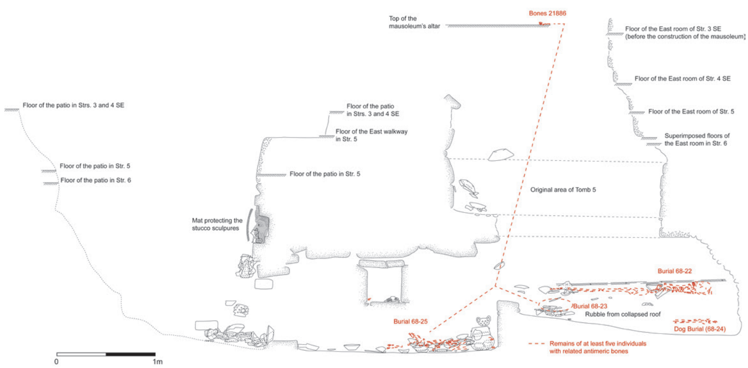


Figure 6b: Profile of Lambityeco tomb 6 showing the distribution of burials and offerings. (The crypt was used as members of the descent group built several houses one over the other.)

In houses seemingly inhabited by ritual specialists, such as rainmakers, several features were added. During the construction of the house, its symbolic centering began by placing a tableau of miniature figurines in the middle of the open courtyard as a dedicatory offering to the ancestors. (One such tableau includes five richly attired ceramic figures, some carrying divination mirrors and others incense pouches, as if invoking the stone simulacrum of an ancestral bundle, while a band of musicians blow shell trumpets.) The corner rooms of the house served specific purposes related to weather forecasting and the ritual management of water. Peripheral walkways around the courtyards and the surrounding rooms were designed to accommodate circumambulatory processions that came into the house's courtyard through two entrances facing the room dedicated to the ancestors. Furthermore, special offerings of ceramic boxes in groups of five meant to safeguard rainwater were kept in the east room and eventually deposited as offerings under the room but above the household crypt (Figure 2.7).

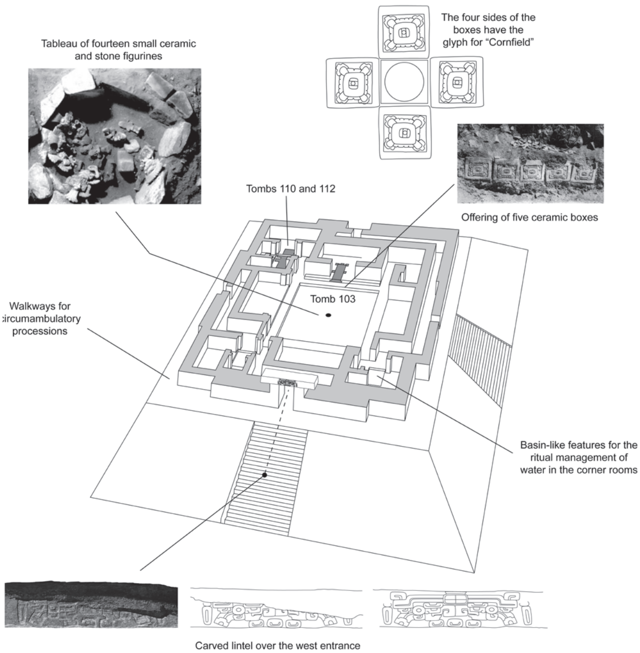


Figure 7: Isometric view of the house of Monte Albán tomb 103 and its special features as seen from the west (photos of the offerings courtesy of INAH-SINAFO; photo of the carved lintel by the author).

Complexes and Compounds

Fivefold spatial arrangements also characterized the layout of the monumental architectural complexes that were home to the highest-ranking descent groups of the most powerful corporate associations. In addition to the house or palace of the head descent group, these complexes included a high temple facing a plaza group with an ancestor memorial in the centre, and a ballcourt (Figure 8). Given that ballcourts where stages where mock battles disguised as a ball game were performed as a prelude to the sacrifice of war captives, these architectural facilities signal the ability of dominant corporate groups to conscript an army and fund warring parties, and of their high-ranking members to form part of a military organization. The ancestor memorial in the centre of the plaza group was invariably a quincunx structure, that is, a miniature courtyard enclosed by four small rooms, set atop a shallow platform reached by a small staircase on each side (Figure 9).

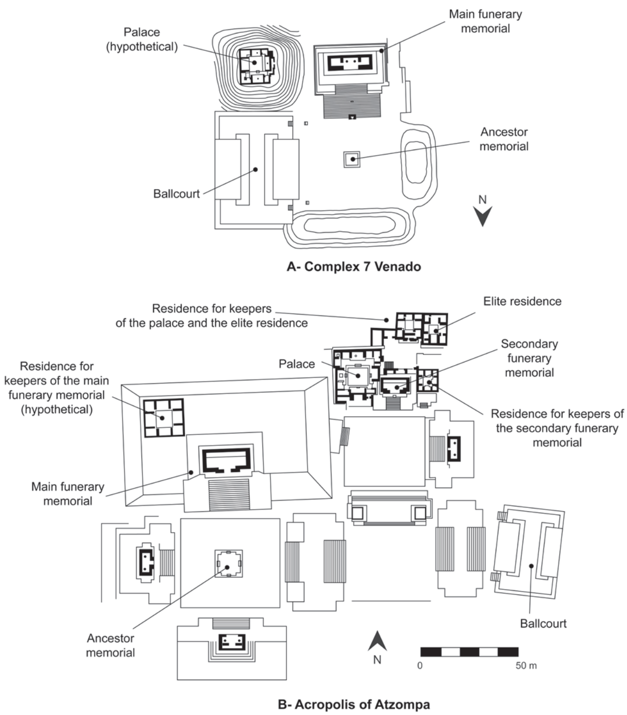


Figure 8: Architectural hubs of two high-ranking corporate groups at Monte Albán (drawing of A modified from Urcid 2001: 132; drawing of B based on the 3D models by Matthew Brennan 2015).

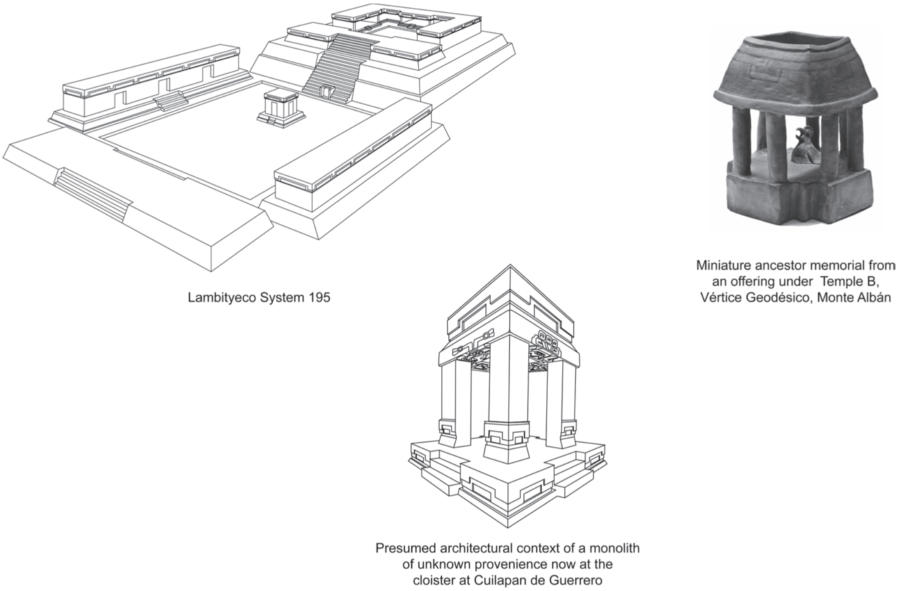


Figure 9: Isometric renditions of ancestor memorials built at the center of the plazas-temples in the architectural seats of high-ranking corporate groups. (The top right example is a miniature ceramic rendering of such memorials, photo after Matos Moctezuma 2011: 98.)

Some communities had only one such complex, larger settlements had more, and certainly the largest of all is the one comprising the summit of Monte Albán. Because of the regional administrative role of this complex's inhabitants—the paramount corporate group in the city—its plaza group had multiple temples, a unique and large-scale administrative centre on the northern end, and a ballcourt tucked next to the administrative centre, on the plaza's northeastern corner. The complex also included, here and there, homes for a large number of lower-ranking descent groups that maintained all the buildings and their facilities, and segregated in a singular way the domain of the living rulers from the realm of their ancestors (Figure 2.10).

Members of the royal household inhabited the largest known house in the region, which is characterized by a sizeable central courtyard surrounded by spacious rooms, the courtyard being flanked on either side by a subsidiary courtyard with more rooms. Perched on an expansive shallow platform on the southeastern side of the complex's main plaza and accessed by a broad staircase that is disproportionate with the narrow entryway to the house, this royal palace is devoid of a crypt. And yet, several lines of evidence strongly

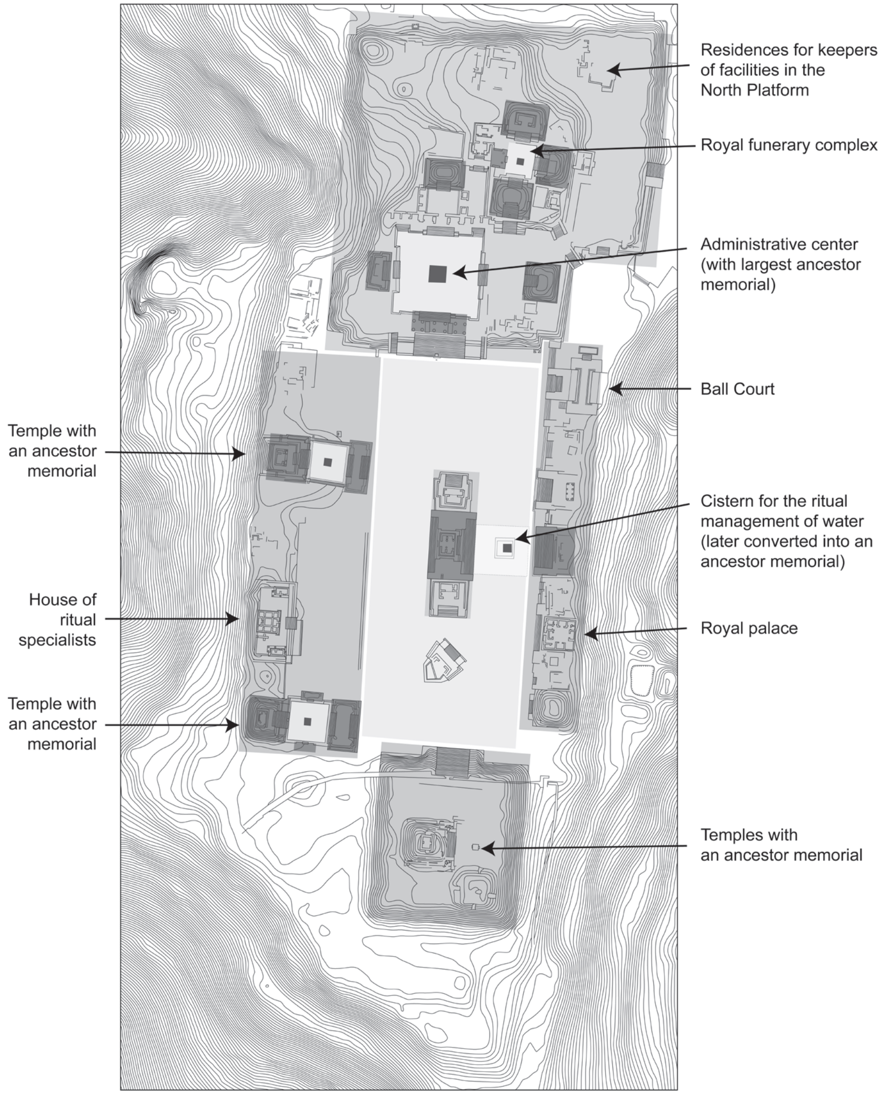


Figure 10: The Main Plaza at Monte Albán (map redrawn from Peeler 1994).

support the inference that the royal tomb or tombs lie beneath the highest and most secluded part of administrative center. This cloistered area has a central courtyard that once had an ancestor memorial in the centre, surrounded by four buildings, three of which once had two-room temples atop lofty platforms. What remains of the fourth one, on the west side—also a two-room temple resting on a shallow platform—are two stone columns, each carved with a sign that references the Sun. The tall buildings of this funerary complex are the result of architectural accretion over time, with evidence that earlier two-room temples had stone columns with other symbolic references to the Sun or with royal ancestors depicted as jaguar–lords and identified by their calendar names (Figure 2.11). The spatial decoupling of the living from the dead in the main plaza at Monte Albán effectively paired, conceptually, the house of the royal ancestors with the locus of decision-making, adding a forceful dimension of their role in political legitimization.

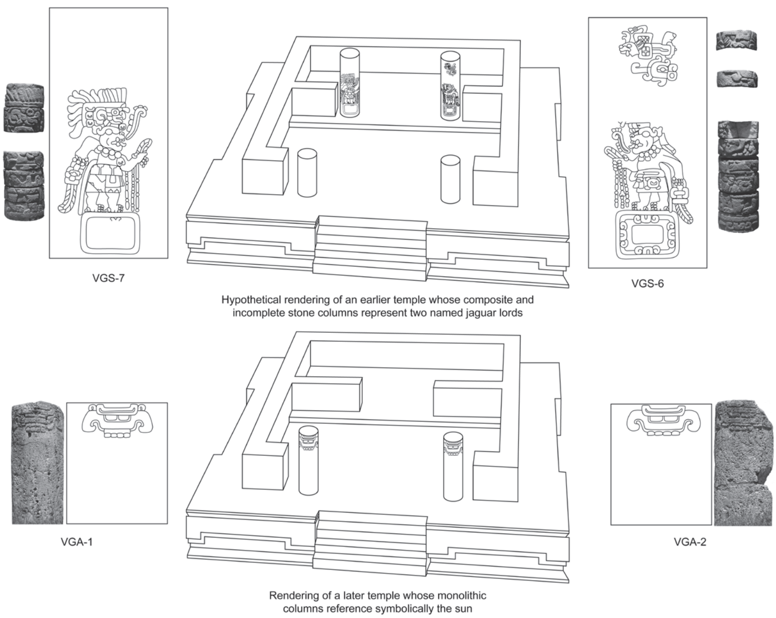


Figure 11: Isometric view of two-room temples with carved columns associated with the royal funerary complex at Monte Albán (photos by the author).

The grand scale and summit location of the main plaza at Monte Albán presented challenges in draining the vast expanse of the plaza itself as well as of the several courtyards in the associated architectural complexes. These challenges were met by building an extensive network of underground masonry tunnels. Some of the branches in this network appear to lead to a reservoir, three to four metres deep, built on a lower terrace in the northern slopes of the city. The architectural configuration of this reservoir partially mimicked the form of a house: when full, the body of water stood for a central courtyard and was surrounded by rectangular platforms that probably supported roofed rooms (Figure 2.12).

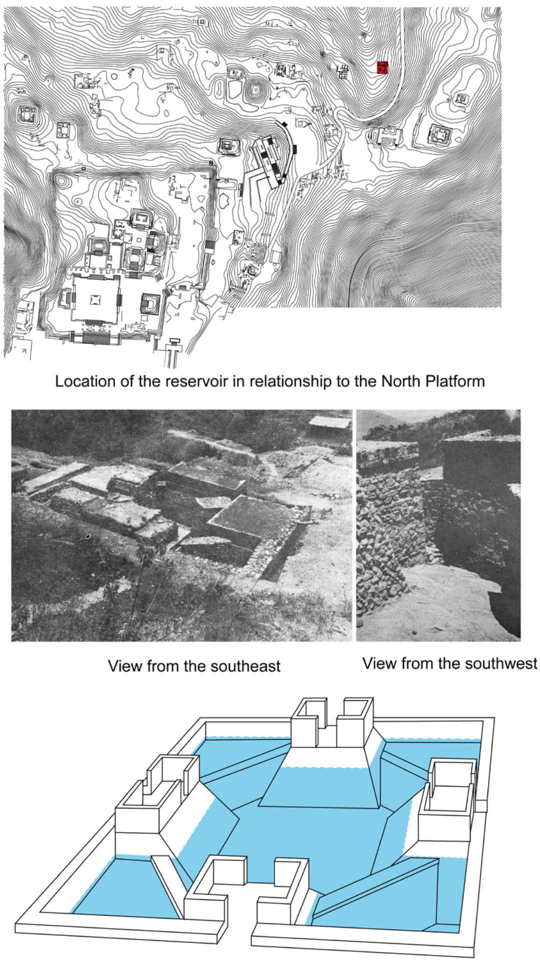


Figure 12: Hypothetical isometric view of the reservoir at the base of a gorge in the northeast slope of Monte Albán (map redrawn from Peeler 1994; photos after Acosta 1976: 25 and 26).

At some time in the history of the city, someone commissioned the construction of a square, stone-lined cistern near the centre of an imagined and only partially realized architectural quincunx. Two of presumably four drainage tunnels linked areas where rainwater was captured from the roofs of the adjacent buildings and directed to the human-made pond. Over time, people left numerous offerings around it. At some point, the reservoir was reduced in size when a smaller cistern was built within it. Eventually, when the construction of this facility for the public ritual management of water was cancelled and replaced by an ancestor memorial, the cistern "received" a massive termination offering, and caches of ceramic vessels were placed at the entrances to the drainage tunnels, rendering them inactive. Among the offerings that filled in the cistern were five young males who were immolated. The males were seemingly arranged in a quincunx, with the one in the centre wearing a composite jade pendant with the face of a person covered by a bat mask—an animal with a symbolic link to sacrifice and maize. Many other offerings were place outside and around the cistern, including five lidded ceramic boxes bearing on their sides the sign for water (Figure 2.13).

Effigy Vessels

A key object that mediated social relations and co-constituted the economic, political, and religious practices of those ancient peoples was the effigy vessel (Caso and Bernal 1952; Pacheco Arias 2014; Sellen 2002, 2007; Urcid and Sellen 2009). By the fourth century CE, this type of artifact was already part of a tradition stretching back nearly a millennium, when some such containers were bottle-like receptacles and some were pedestal-like braziers in human shape. As time went on, a complementary and novel trend was the manufacturing of a separate human effigy attached on one side to a cylindrical container. Also crafted were big and small ceramic statuettes devoid of a receptacle. These stunning and powerful materializations of ancestral spirits display a wide gamut and many permutations of signs. They are effectively personifications of mortals, reifications of the divine, and embodiments of alter egos. A fair number of effigy vessels and their facial attributes fall into categories that match most of the 20 day names of the calendar, thus associating them with the 13 core patron deities who presided over or influenced the fate of persons given their day of birth (Figure 2.14). Such associations suggest that the personification of ancestral spirits was integral to scrying processes aimed at interpreting dreams, discovering hidden knowledge and motivations, or foretelling future events.

The great majority of urns present the human figure in a seated, cross-legged, position. The hands rest on the knees, hold an object in each hand, or clasp together an artifact. Their faces are at times fully or partially concealed by a mask that conflates features of one or more creatures such as the alligator, serpent, owl, bat, or jaguar. Often, these ancestors-made-present display elaborate headdresses with panoplies of feathers beautified with iconic,

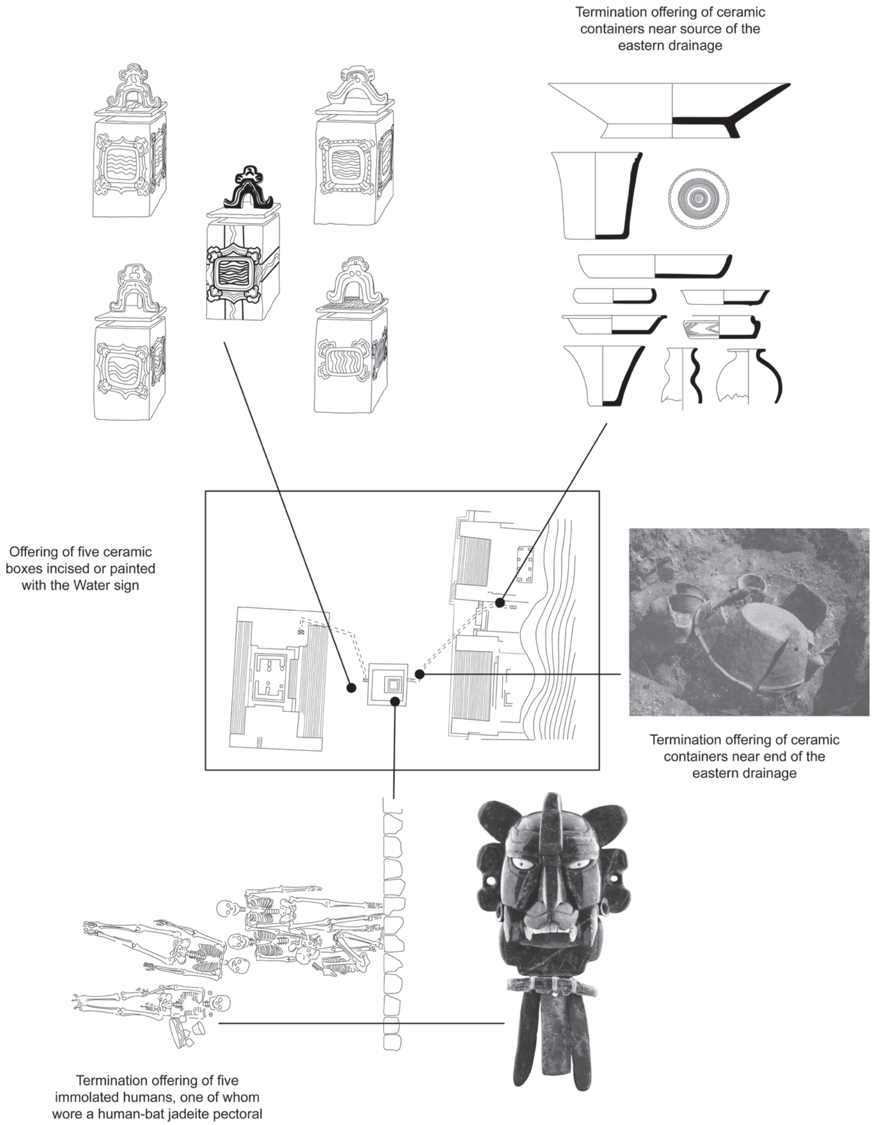


Figure 13: Cisterns and feeding drainages on the east side of the Main Plaza at Monte Albán used for the ritual management of water (map redrawn from Peeler 1994; photo of the offering after Acosta 1974: 73; photo of the pectoral after Matos Moctezuma 2011: 53).

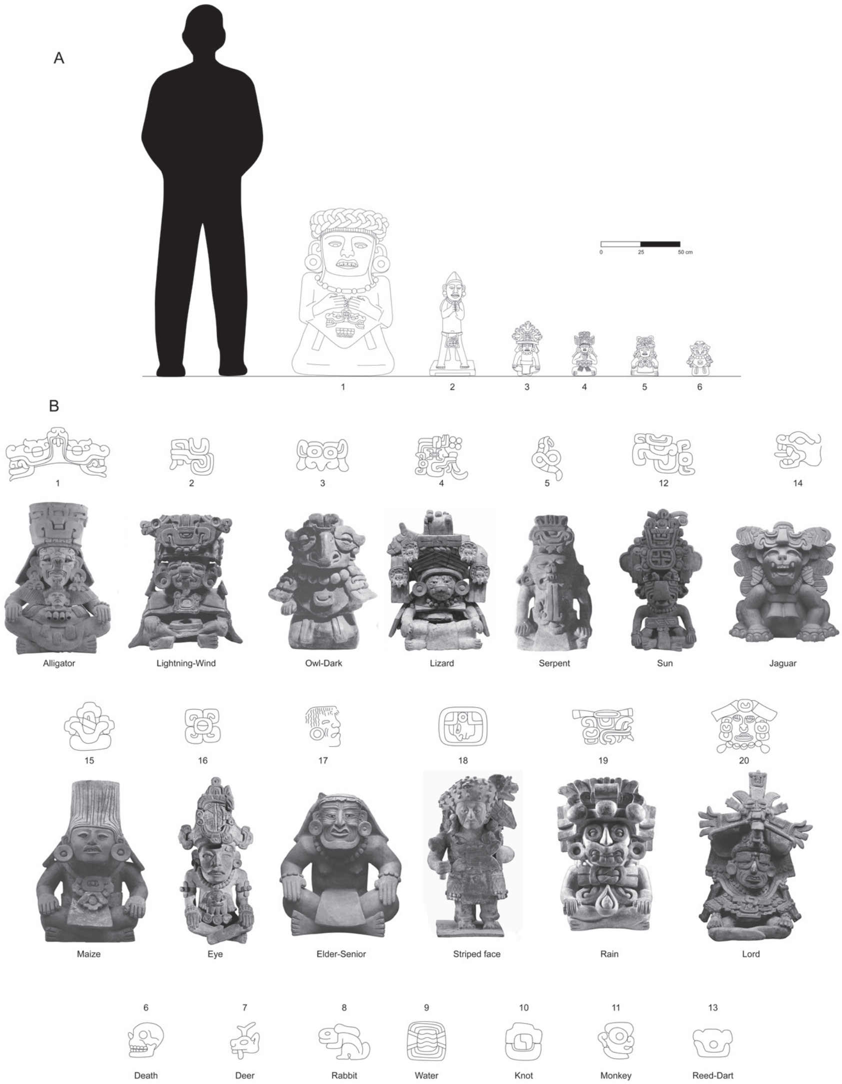


Figure 14: [A] Range of size in effigy vessels, and [B] type effigy vessels and their day sign correlates (the day names in the bottom row do not have recognizable counterparts in the urn).

indexical, and symbolic references. When these headdresses are omitted and the human head is shown with the hair combed and parted straight down the centre, the effigy vessels conflate a person with maize, substituting symbolically the human hair with the silk of the corncob. Clothing is gender specific—blouse and long skirt for women, short kilt or loincloth for men—and symbolism abounds in sumptuous ornaments, which include ear flares, nose or lip plugs, collars, pectorals, pendants, and bracelets. A few of the known urns combine different materials, such as shell or coral inlays; at times, even wood and stone-sculpted versions of effigies were created. Many of the effigy vessels found in elite contexts retain traces of having been painted with multiple colours, and the great majority of effigies, whether painted or not, were sprinkled with red cinnabar during ritual processes.

There is no doubt that urns where manufactured in many communities, and their wide regional distribution was facilitated by market exchange, gifting, tribute payments, pilgrimages, migrations, and perhaps even war. Although the great majority of complete effigy vessels have been found as offerings in tombs, and a lesser number come from caches associated with the architectural seats of corporate groups, the relative abundance of fragments in construction fill and in surface scatters implies that many effigy vessels were used in a myriad of contexts before being placed in crypts and caches. And while most vessels in their final resting place are empty, their receptacles may have held various contents during previous uses. Also, vessels found empty in the homes of ancestors may not have been empty when they were buried, but could have held water or been intended to symbolically receive it.

Tableaus

In addition to their diversity in symbolic attributes, urns vary in size, and most importantly in the way they were arranged. Many urns formed sets of four or five identical or similar pieces that were arranged as tableaus. Through such arrangements, people likely told stories and activated the potency of the personifications. One of the earliest known tableaus, dating to the first century CE, was placed as a consecrating offering in the centre of what may have been a fivefold set of caches under the supporting platform of a double-room temple associated with a royal house (Figure 2.15). It included a large effigy with the personification of the rain god in a prone position and holding a bolt of lightning. This effigy was placed atop a small stone enclosure that concealed a small effigy vessel sitting inside a shallow conical vessel, like those commonly used for eating. The urn is an embodiment of the corncob and appears as if "served in a plate." Next to it were the skeletal remains of a sacrificed quail. Outside the enclosure lay the paired antlers of a deer, which are still used today by rainmakers as drumsticks to hit a turtle carapace and call for rain. Behind the antlers, arranged in a single row, were four smaller effigy vessels with female-gendered versions of the rain deity. The tableau recounts a pan-Mesoamerican

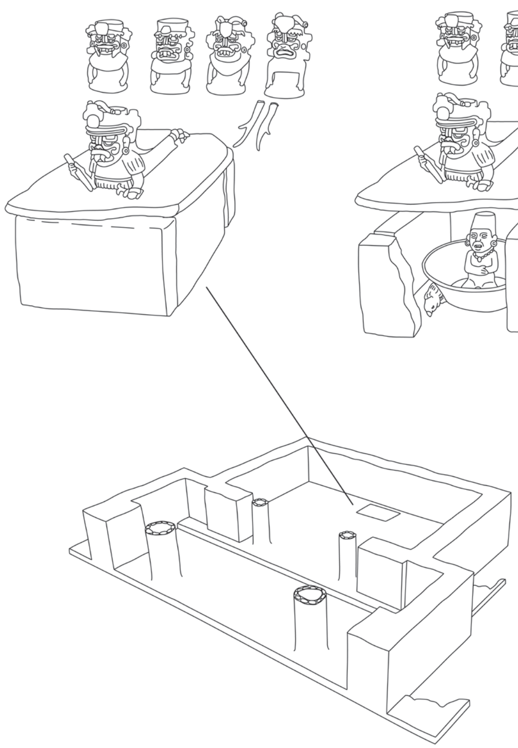


Figure 15: The tableau in the central cache under temple 35 at San José Mogote (based on drawings by Marcus and Flannery 1996).

origin story in which the rain deity—assisted by four attendants, each assigned to one of the quadrants of the world—releases with a bolt of lightning nature's wealth within a mountain of sustenance, spreading maize to the four directions to feed people and to teach them how to cultivate it (López Austin and López Luján 2004).

Half a millennium after this offering was dedicated, circa 500 CE, another fivefold tableau was left at the entrance of a tomb in the house of a high-ranking household at Monte Albán. In this case, a large effigy vessel representing a seated personage who embodies a lizard presided in the centre of a quadripartite arrangement of small, identical effigy vessels personifying corncobs. The main personage, probably a shaman rainmaker, is seemingly depicted in another effigy vessel placed in the facade of the crypt (this one has the emblem of the "Fire Serpent" in the headdress, an insignia related to the impersonation of lizards). The same personage is also mentioned in the inscribed slab that sealed the entrance to the tomb, and is rendered and named in the painted

muralsthat embellish the walls of the crypt. This and other murals in tombs invariably depict full-body, paired sets of later household heads as if walking in procession toward a founding couple or a single apical ancestor (Figure 2.16). These ancestral beings are painted on the back wall of the tombs, and are depicted either as is or by their glyphic calendar names. Except for differences in posture— walking in procession versus sitting cross-legged—these two-dimensional renditions replicate the accoutrements and symbolic attributes common in effigy vessels. And yet, effigy vessels were never represented as objects in the murals or carved monuments.

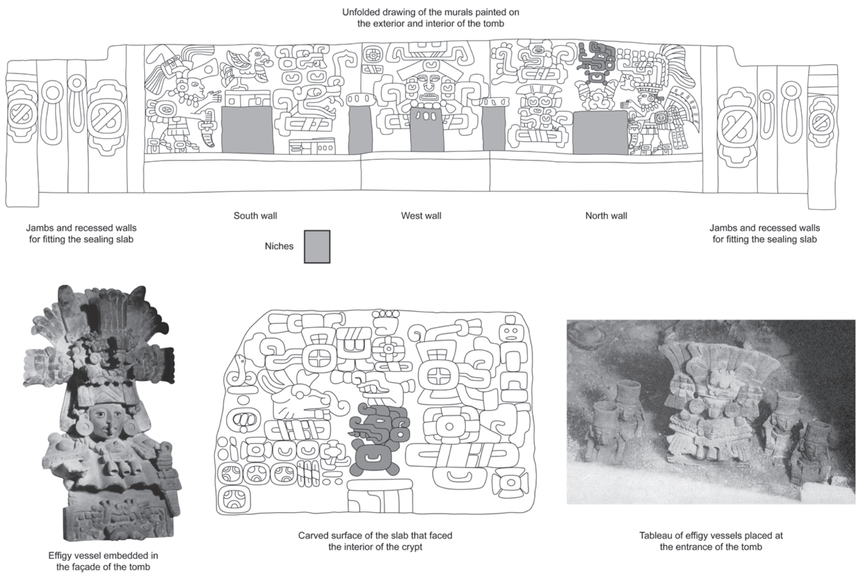
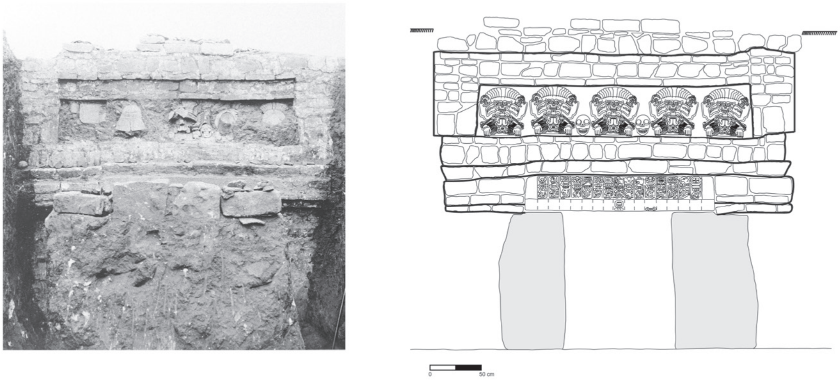
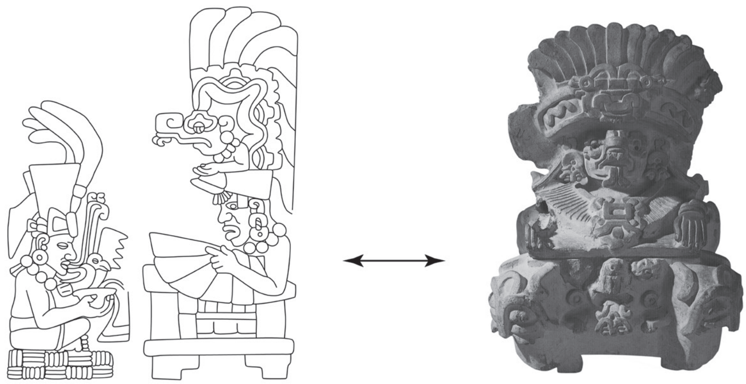


Figure 16: Genealogical record in different media from Monte Albán tomb 104 (the highlighted glyph inscribed on the sealing slab and painted on the north wall of the tomb [1 Lizard] corresponds to the personification in the central effigy vessel from the tableau) (photos by the author and after Caso 1938)

Another example of a quintuple set of effigy vessels, this one found at Xoxocotlán (a settlement close to Monte Albán), consisted of five covers from boxes of the box-and-lid type that, after multiple uses, ended up in the recessed entablature of the facade of an elite tomb. The covers include personifications of the rain god and, when originally accompanied by their box-like bases, rendered the ancestors as if displayed inside funerary crates (Figure 2.17). As would be



A



Detail on the top register in the frontal surface of the stela from Cerro de la Campana tomb 5, Suchilquitongo. The scene depicts a youngh lord presenting an offering to an ancestral bundle inside a crate.

Box-lid urn from the first occupation of Monte Albán tomb 7

B

Figure 17: [A] Five covers of box-lid type urns on the façade of Xoxocotlán tomb 3 (when excavated, the covers were found protected by conical vessels); [B] The box-lid type effigy vessel as depiction of a funerary bundle (photo of the tomb's facade by Marshall Saville courtesy of the American Museum of Natural History; photo of the effigy vessel after González Licón et al. 1990: 43).

expected after the setting and re-setting of these tableaus, many of the sets must have been reduced in number through a process of attrition, when effigy vessels were damaged and eventually broke. There is, however, some evidence that pieces comprising sets were dispersed in order to disseminate their affective and agentive power (Figure 2.18).

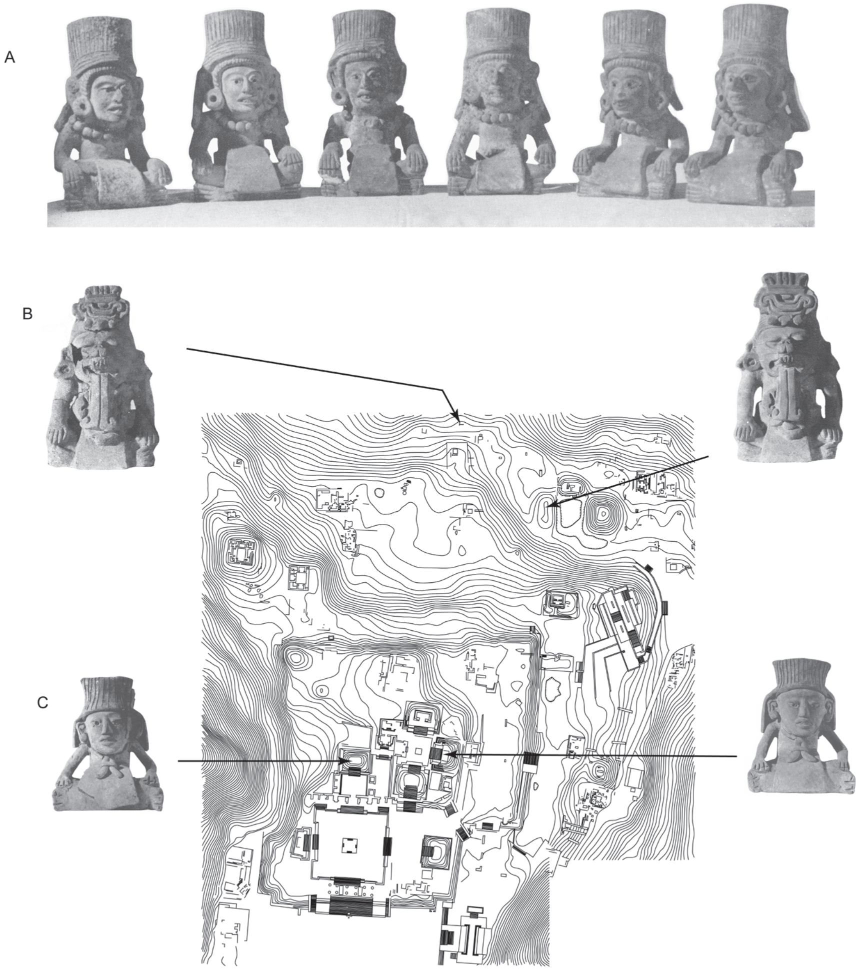


Figure 18: Attrition and dispersal of urn sets at Monte Albán. [A] Remaining six identical personifications of maize, some of them incomplete, from two sets of four; [B] identical effigy vessels of "person-serpent" found in two different context; [C] identical personifications of maize found in the offerings of different buildings (map redrawn from Peeler 1994; photos after Caso and Bernal 1952: 127, 129, and 158).

Other ceramic representations of ancestors, with more or fewer symbolic attributes, are identified by their glyphic calendar names, (Figure 2.19). Several occur as pairs in which one of the urns is distinguished by its larger size. It may well be that large groups of paired effigy vessels served as three-dimensional media to convey, as tableaus, genealogical records. A single effigy vessel found in an elite tomb at Dainzú depicts a woman as if begetting a son. The newborn is indicated by the calendar name "1 Jaguar," below which appear the genitalia of a male, (Figure 2.19, no. 9). Known examples of female ancestral figures marked by their unique names may identify key trans-generational members of groups through whom the descent was traced. Alternatively, they may allude to an apical ancestor's polygyny, a well-attested practice among Mesoamerican nobilities, as corporate groups accrued the craft labour of multiple wives, their biological reproductive potential, and the concomitant wealth from their production and reproduction. Still another possible interpretation is that these figures depict the synchronic and prolific female progeny of a noble couple, alluding perhaps to the human resources that, through marriage arrangements and dowry payments, were deployed to make alliances with equally affluent or more powerful corporate groups.

In addition to fourfold and fivefold sets, scores of urns appear to have been crafted as singular, unique items. These offer a glimpse of the myriad of social roles and their associated cultural codes: young adults and elders with all the trappings of lordship (e.g., jaguar helmet, speech scrolls, and references to the Sun); a rainmaker beating a tortoise carapace with an antler; a person wearing a helmet with the image of a butterfly; a woman wearing a jaguar helmet and seated cross-legged on a "mountain of sustenance"; a religious specialist wearing the flayed facial skin of a sacrificial victim while holding a decapitated head and a rattling staff; a warrior holding a bat-claw vessel and carrying a trophy head as a pendant; or a person–bird with the head of a jaguar (Figure 2.20).

The popularity of effigy vessels extended beyond the Central Valleys of Oaxaca, to Nejapa and San José del Palmar in the east; Ejutla, Miahuatlán, and Bajos de Chila in the south; Sola de Vega in the southwest; Silacayoapan, Yatachio, and Jicotlán in the west; Valerio Trujano in the northwest; and Macuiltianguis (near Ixtlán) and Ixtepeji in the northeast. Wherever they were used, these objects fostered social cohesiveness and brought to the forefront the ontological dimensions of personhood. Their endurance over more than a millennium and their vast spatial distribution attest to this popularity. At the level of corporate groups, effigy vessels facilitated membership recognition and common identities, while at the same time linking the domains of the living and the dead. The imagery of effigy vessels also highlights the ethno-taxonomic fluidity among human beings, non-human beings, and other-than human beings, emphasizing relational ways of understanding the world and the continuous morphing of persons, alter egos, parallel companions, and the divine.

Figure 19: Effigy vessels with named personages that seemingly conveyed affinal and consanguineal relationships.

Figure 20: Singular effigy vessels that may not have been part of quintuple sets.

The more-distant distribution of effigy vessels suggests trade routes, diasporic destinations, and travel circuits. Or perhaps even emulations for the sake of prestige or the forceful impositions of cultural practices, with known examples of urns from Tehuacán in the Mixteca Baja and urns from San Sebastian near Puebla City. Albeit a short-lived phenomenon spanning the third and fourth centuries of the Common Era, migrants from the Central Valleys of Oaxaca established an enclave at Teotihuacan, the megalopolis in the basin of Mexico that maintained control and influence over large expanses of Mesoamerica. They brought with them effigy vessels that had been made in Oaxaca, or manufactured them locally using readily available clays (Figure 2.21).

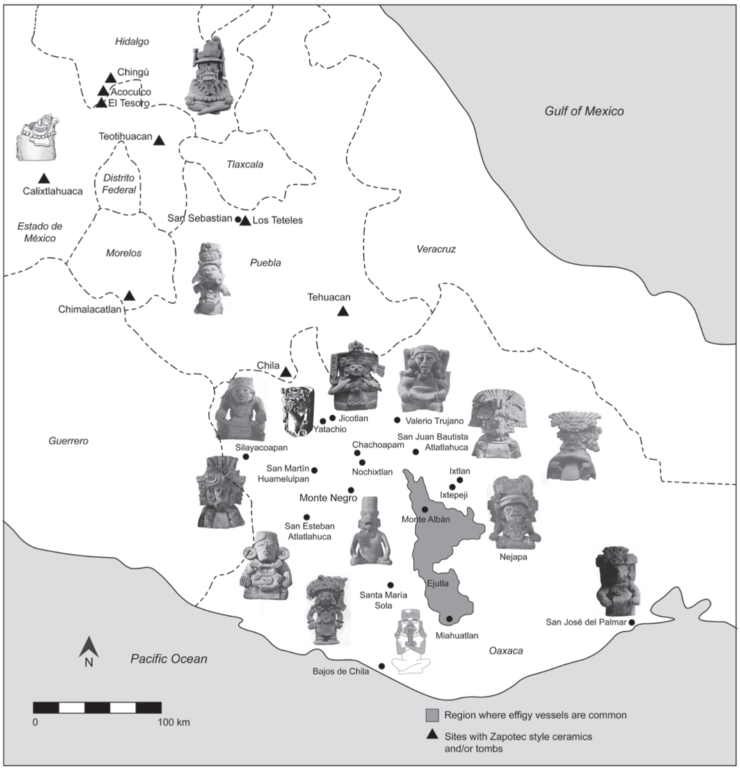


Figure 21: The Central Valleys of Oaxaca and effigy vessels from neighboring and distant regions (photos and drawings after Boos 1966, Caso 1949, Caso and Bernal 1952, Ortega and Nukyen 2014, Paddock 1953; Smith and Lind 2005, Winter 2004, Montiel et al. 2014; data on the distribution of Zapotec style ceramics and tombs after Smith and Lind 2005).

By the mid-ninth century CE, a complex set of political, economic, and environmental factors led unremittingly to the demise of Monte Albán and its regional footprint. Seeking better opportunities elsewhere, its inhabitants slowly but steadily abandoned the city. Concomitant with this process, the millennial script lost prestige, and the style and aesthetics of effigy vessels changed. By around the thirteenth century CE, Monte Albán had become a small village, other thriving communities in the Central Valleys continued coalescing around descent and corporate groups, and people persisted in interpreting the world as a quincunx. They built houses, palaces, and monumental groups as quadripartite arrangements around open courtyards and plazas, buried their dead in the domestic realm, and evoked and invoked their ancestors. Scribes deployed a new script based more and more on logophonic principles, and potters continued crafting receptacles with effigies but in smaller numbers. Several settlements that became regional centres never reached the urban proportion of the ancient ruined city, despite the fact that the population density in the region continued to the rise (see Monte Albán as Place of Origins).

When the Spaniards began their invading forays into the Central Valleys in 1521, their *nahuatl*-speaking scouting parties referred to the local inhabitants as "people of the *tzapotl*," in reference to common local trees that yield several of the species of pan-tropical fruits now classed in the families Sapotaceae and Ebenaceae. Since then, the indigenous peoples that predominate in central Oaxaca most frequently designate themselves, and are referred to by others, as *Zapotecas* (in Spanish) or Zapotec (in English). Yet, there is still a lingering memory that the ancients identified themselves in their own language as the *Beni Zaa* (People of the Clouds). This name underscores the role that rain, thunder, and lightning played in centering the world of the agrarian peoples and societies from this region of Mesoamerica, irrespective of their specific linguistic, ethnic, or corporate identities.

MONTE ALBÁN AS PLACE OF ORIGINS

Even after Monte Albán became desolate, its former splendour and numinous character brought people to its collapsed buildings and abandoned residential terraces to pay homage to ancestral spirits and to memorialize the past (Joyce 2004). Those pilgrims, devotees, and seekers sometimes left small tokens and offerings of miniature clay vessels amidst the rubble of fallen structures. Sometime in the fifteenth century, members of the paramount noble house of one of the political capitals then

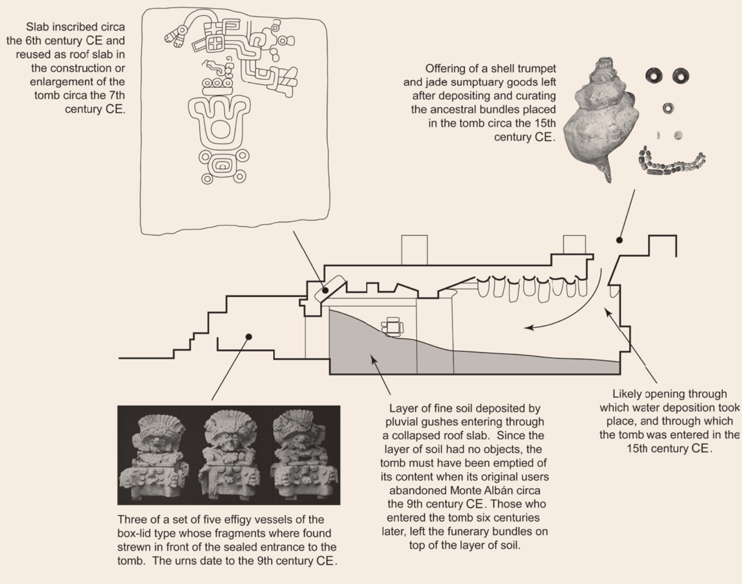
thriving in the near periphery ascended Monte Albán looking for a place to deposit the mortuary bundles of several of their ancestors, and ultimately reused the tomb of an abandoned mid-ranked elite house situated on a broad terrace immediately below the North Platform (see Figure 4, left). The astounding craftsmanship and material wealth of the sumptuary goods with which these ancestors were decked, and of the other objects left with the bundles—several of which were likely related to divination—bespeak the economic and political power of their living relatives (Caso 1969).

Box 3.1: Some of the material wealth that accompanied the ancestral bundles placed in Monte Albán tomb 7 in the 15th century A. D. (photos after Caso 1969, Sánchez Scott 2001, and Fields et al. 2012).

It may well be that they came from nearby Zaachila, some 10 kilometres south of Monte Albán and the seat of the dominant kingdom in the Central Valleys of Oaxaca during the two centuries prior to the Spanish conquest (see Figure 1). The royal houses of this and other polities established vast networks of inter-regional interaction, amassing goods made out of exotic materials from far and wide and monopolizing specialized knowledge and local artistic production (Pohl 2003).

These royal houses had access to the art of working metal alloys; polychrome and shellacked pottery; miniaturized carvings on small objects made out of shell, bone, and wood; lapidary industries in obsidian, jade, quartz, and alabaster; and mosaic work with diminutive, inlaid tesserae of turquoise, coral, shell, and green stones. Because of their regional influence and long-distance alliances, members of these royal houses spoke various languages and shared an elite identity that cut across ethnic and community affiliations.

Given the social role that ancestral remains continued to play during the fourteenth and fifteenth centuries CE, it appears that a local political crisis motivated the re-interment of this particular family's funeral bales. The bundles—likely wrapped in fine textiles that soon disintegrated—may have originally contained the dried bones of discrete individuals. Yet, anatomical representation and the way the skeletal remains were found—some seemingly carefully arranged within circles of stones and others in much disarray—suggest that the remains had been actively manipulated in other contexts, and may have been further used for some time in their new abode. What prompted the re-interment? Did a dispute in the trans-generational transfer of properties and rights require the temporary concealment of key supporting evidence? Was the family re-establishing a genuine link to the household members of a corporate group that once lived at Monte Albán during its heyday, and thus attempting to increase the oracular power of the bundles? Or were these newcomers seeking prestige by falsely claiming a noble ancestry with the former elites of the ancient city?



Box 3.2: The taphonomy of Monte Albán tomb 7 (photos of effigy vessels and of the late external offering after Caso 1969: figure 28 and plate III).

The placing of the bundles in a tomb that had been almost emptied when the exodus out of Monte Albán began some 400 years earlier seems to have been coincidental. For one thing, the crypt was not reopened through its entrance. Rather, well before the tomb was inhabited once again, a roof slab on its posterior chamber collapsed. Over the course of a few rainy seasons, water that bounced off the the interior surface of the slab that sealed the crypt's entrance left a sloping, fine-grained soil deposit over the original floor of the tomb. Entering what may have been initially construed as "a small crevice into the earth," the carriers of those bundles placed them on top of the pluvial soil deposit, and curated and used them there for some time, perhaps even garbing them as deities. Eventually, the carriers left the bundles in the tomb, accompanied by their personal belongings, their godly references, ritual paraphernalia related to scrying and divination, and offerings. Then, they sealed the opening in the tomb's roof and left an offering amidst the rubble of the ruined house. Although the mortuary bundles and their associate material wealth were uncovered in the 1930s, the fate of those surviving kin who placed them at Monte Albán was forever lost.

Acknowledgments

I extend my appreciation to Justin Jennings and Adam Sellen for their kind invitation to participate in this remarkable project. Thanks also to two anonymous reviewers who prompted me to clarify some ideas. Elbis Dominguez deserves special mention for crafting the outstanding figures that accompany this essay.

References Cited

Acosta, Jorge. 1974. "Informe de la XIVa Temporada de Exploraciones Arqueológicas en Monte Albán, Oaxaca (1945-46)." *Cultura y Sociedad: Revista Anual de Antropología*. Año 1, tomo 1 (2): 69–82. México.

——. 1976. "La XIII Temporada de Exploraciones Arqueológicas en Monte Albán (1944-45)." *Cultura y Sociedad: Revista Anual de Antropología*. Año 3, tomo 3 (4):14–26. México.

Alcina Franch, José. 1983. *Pre-Columbian art*. New York: H. N. Abrams.

Augur, Helen. 1954. *Zapotec*. Garden City, New York: Doubleday.

Berjonneau, Gérald, and Jean-Louis Sonnery. 1985. *Rediscovered Masterpieces of Mesoamerica, Mexico-Guatemala-Honduras*. Switzerland: Editions Art.

Berrin, Kathleen, and Esther Pasztory, eds. 1993. *Teotihuacan: Art from the City of the Gods*. The Fine Arts Museums of San Francisco. Thames and Hudson.

Blanton, Richard. 1978. *Monte Albán: Settlement Patterns at the Ancient Zapotec Capital*. New York: Academic Press.

Blanton, Richard, Gary Feinman, Stephen Kowalewski, and Linda Nicholas. 1999. *Ancient Oaxaca: The Monte Albán State*. Cambridge: Cambridge University Press.

Boos, H. Frank. 1966. *The Ceramic Sculptures of Ancient Oaxaca*. South Brunswick, New York: A. S. Barnes.

Brennan, Matthew. 2015. *Atzompa*. Instituto Nacional de Antropología e Historia and the Virtual World Heritage Laboratory, Indiana University. http://www.atzompa.org/thesite/

Caso, Alfonso. 1938. *Exploraciones en Oaxaca. Quinta y Sexta Temporadas 1936-37*. Instituto Panamericano de Geografía e Historia no. 34. Mexico.

Caso, Alfonso. 1949. Una Urna con el Dios Mariposa. *El México Antiguo*, tomo 8:78–95. Mexico.

——. 1969. *El Tesoro de Monte Albán. Memorias del Instituto Nacional de Antropología e Historia no. 3*. Mexico: Secretaría de Educación Pública.

Caso, Alfonso, and Ignacio Bernal. 1952. *Urnas de Oaxaca*. Mexico: Instituto Nacional de Antropología e Historia.

Covarrubias, Miguel. 1957. *Indian Art of Mexico and Central America*. New York: Alfred A. Knopf.

Disselhoff, Hans D., and Sigvald Linné. 1961. *The Art of Ancient America: Civilizations of Central and South America*. New York: Crown Publishers.

Espinosa Yglesias, Amparo. 1992. *Un recorrido por el Museo Amparo*. Mexico: El Museo, Puebla.

Feinman, Gary, Linda Nicholas, and Helen Haines. 2002. "Houses on a Hill: Classic Period Life at El Palmillo, Oaxaca, Mexico." *Latin American Antiquity* 13 (3): 251–77.

Fields, M., John M. D. Pohl, and Victoria I. Lyall. 2012. *Children of the Plumed Serpent: the legacy of Quetzalcoatl in ancient Mexico*. Los Angeles, CA: Los Angeles County Museum of Art.

González Licón, Ernesto, Lourdes Márquez Morfín, Marcus Winter, and Enrique Méndez. 1990. *Monte Albán*. Mexico: El Equilibrista; Madrid: Turner Libros.

Joyce, Arthur. 2000. "The Founding of Monte Albán: Sacred Propositions and Social Practices." In *Agency in Archaeology*, edited by Marcia-Anne Dobres and John Robb, 71–91. London: Routledge.

——. 2004. "Sacred Space and Social Relations in the Valley of Oaxaca." In *Mesoamerican Archaeology*, edited by Julia A. Hendon and Rosemary A. Joyce, 192–216. Malden: Blackwell.

——. 2010. *Mixtecs, Zapotecs, and Chatinos: Ancient Peoples of Southern Mexico*. London: Wiley-Blackwell.

Joyce, Arthur, and Marcus Winter. 1996. "Ideology, Power, and Urban Society in Pre-Hispanic Oaxaca." *Current Anthropology* 37 (1): 33–47.

Kowalewski, Stephen. 1990. "The Evolution of Complexity in the Valley of Oaxaca." *Annual Review of Anthropology* 19: 39–58.

Kowalewski, Stephen, and Marcia Truell. 1970. "Tlaloc" in the Valley of Oaxaca. *Boletín de Estudios Oaxaqueños* no. 31, Mitla, Oaxaca, Mexico.

Kowalewski, Stephen, and Laura Finsten. 1983. "The Economic Systems of Ancient Oaxaca: A Regional Perspective." *Current Anthropology* 24 (4): 413–41.

Lind, Michael. 1994. Monte Albán y el Valle de Oaxaca durante la fase Xoo. In *Monte Albán, Estudios Recientes, Projecto Especial Monte Albán* 1992–94, edited by Marcus Winter, 99–111. Oaxaca, Mexico.

Lind, Michael, and Javier Urcid. 2010. *The Lords of Lambityeco: Political Evolution in the Valley of Oaxaca during the Xoo Phase*. Boulder: University Press of Colorado.

López Austin, Alfredo, and Leonardo López Luján. 2004. "El Templo Mayor de Tenochtitlan, el Tonacatépetl y el mito del robo del maíz." In *Acercarse y mirar: Homenaje a Beatriz de la Fuente*, edited by María Teresa Uriarte, 403–456. Mexico: Instituto de Investigaciones Estéticas, Universidad Nacional Autónoma de México.

Marcus, Joyce, and Kent Flannery. 1996. *Zapotec Civilization: How Urban Society Evolved in Mexico's Oaxaca Valley*. New York: Thames and Hudson.

Matos Moctezuma, Eduardo (general coordinator). 2011. *Seis ciudades antiguas de Mesoamérica: Sociedad y Medio Ambiente*. Mexico: Instituto Nacional de Antropología e Historia.

Montiel Ángeles, Alma Zaraí, Victor Manuel Zapien López, and Winter, Marcus. 2014. "La Arqueología del Istmo Oaxaqueño: patrones de asentamiento, comunidades y residencies." In *Panorama Arqueológico: Dos Oaxacas*, edited by Marcus Winter and Gonzalo Sánchez Santiago, 197–244. Arqueología Oaxaqueña 4. Mexico: Instituto Nacional de Antropología e Historia.

Ortega Cabrera, Verónica, and Jorge Nukyen Archer Velasco. 2014. "Pasado y presente de la presencia oaxaqueña en Teotihuacán, México." *Cuicuilco* 21 (61): 137–64.

Pacheco Arias, Leobardo. 2014. "Urnas de Atzompa: Manufactura e imaginería zapoteca." *Arqueología Mexicana* 21 (126) :56–59.

Paddock, John. 1953. "Excavation in the Mixteca Alta." *Mesoamerican Notes 3*. Department of Anthropology, Mexico City College, Mexico.

——. 1966. "Oaxaca in Ancient Mesoamerica." In *Ancient Oaxaca*, edited by John Paddock, 83–242. Standford: Stanford University Press.

Parsons, Lee Allen. 1980. *Pre-Columbian Art. The Morton D. May and the Saint Louis Art Museum Collections*. New York: Harper and Row.

Peeler, Damon. 1994. *Mapa de Monte Albán. Proyecto Especial Monte Albán* 1992–1994, Contribución 6. Mexico: Instituto Nacional de Antropología e Historia, Oaxaca.

Pohl, John. 2003. “Royal Marriage and Confederacy Building among the Eastern Nahuas, Mixtecs, and Zapotecs.” In *The Postclassic Mesoamerican World*, edited by Michael Smith and Frances Berdan, 243–48. Salt Lake City: University of Utah Press.

Ragghianti, Carlo L., and Licia Ragghianti Collobi. 1970. *National Museum of Anthropology Mexico City*. Newsweek, Inc., and Arnoldo Mondadori Editore, Italy.

Robles García, Nelly, Leobardo Pacheco Arias, and Mireya Olvera Sánchez. 2014. “El Señor Ocho Temblor y la Señora Agua, dos urnas zapotecas de elite en Atzompa, Oaxaca: iconografía y conservación.” *Arqueología* 49: 120–133.

Sánchez Scott, Daniel, ed. 2001. *Tesoros de Oaxaca*. Gobierno Constitucional del Estado de Oaxaca e Instituto Nacional de Antropología e Historia, Mexico.

Sellen, Adam. 2002. “Storm-God Impersonators from Ancient Oaxaca.” *Ancient Mesoamerica* 13 (1): 2–19.

——. 2007. *El Cielo compartido: deidades y ancestors en las vasijas efigie zapotecas*. Mérida: Universidad Nacional Autónoma de México, Mexico.

——. 2011. “Sowing the Blood with the Maize: Zapotec Effigy Vessels and Agricultural Ritual.” *Ancient Mesoamerica* 22: 71–89.

Smith, Michael, E. and Michael Lind. 2005. “Xoo-Phase Ceramics from Oaxaca found at Calixtlahuaca in Central Mexico.” *Ancient Mesoamerica* 16 (2):169–77.

Solís, Felipe and Ted Leyenaar. 2002. *Journey to the Land of the Gods: Art Treasures of Ancient Mexico*. De Nieuwe Kerk Amsterdam y Waanders Publishers, in association with Lund Humphries. Amsterdam.

Spencer, Charles, and Elsa Redmond. 2004. “A Late Monte Albán I phase (300–100 B.C.) Palace in the Valley of Oaxaca.” *Latin American Antiquity* 15 (4): 441–55.

Urcid, Javier. 2001. *Zapotec Hieroglyphic Writing*. Studies in Pre-Columbian Art and Archaeology, no. 34. Washington, DC: Dumbarton Oaks.

——. 2005. *Zapotec Writing: Knowledge, Power, and Memory in Ancient Oaxaca*. http://www.famsi.org/zapotecwriting/

——. 2011. “Los oráculos y la guerra: el papel de las narrativas pictóricas en el desarrollo temprano de Monte Albán (500 a.C.-200 d.C.).” In *Monte Albán en la encrucijada regional y disciplinaria. Memoria de la Quinta Mesa Redonda de Monte Albán*, edited by Nelly M. Robles García and Angel Iván Rivera Guzmán, 163-237. Instituto Nacional de Antropología e Historia, Mexico.

Urcid, Javier, and Arthur Joyce. 2013. “Early Transformations of Monte Albán’s Main Plaza and their Political Implications, 500 BC – AD 200.” In *Mesoamerican Plazas: Arenas of Community Building and Power Negotiation*, edited by Kenichiro Tsukamoto and Takeshi Inomata, 149–67. Tucson: University of Arizona Press.

Urcid, Javier, and Adam Sellen. 2009. “A Forgotten House of Ancestors from Ancient Xoxocotlán.” *Baessler-Archiv* 56: 177–224.

Winter, Marcus. 1974. “Residential Patterns at Monte Albán, Oaxaca, Mexico.” *Science* 186 (4168): 981–87.

——. 1990. “Monte Albán: Hilltop Capital in Oaxaca.” In *Mexico: Splendors of Thirty Centuries*, 115–134. New York: The Metropolitan Museum of Art.

——. 2002. “Monte Albán: Mortuary Practices as Domestic Ritual and their relation to Community Religion.” In *Domestic Ritual in Ancient Mesoamerica*, edited by Patricia Plunket, 67–140. Cotsen Institute of Archaeology, University of California, Los Angeles.

——. 2004. "Excavaciones Arqueológicas en El Carrizal, Ixtepec, Oaxaca." In *Palabras de luz, Palabras floridas*, edited by Vicente Marcial Cerque, 17–48. Universidad del Istmo, Tehuantepec, Oaxaca. Mexico.

——. 2011. "Social Memory and the Origins of Monte Albán" *Ancient Mesoamerica* 22: 393–409.

CHAPTER 3

Zapotec Urns: Witnesses to an Ancient Culture

ADAM T. SELLEN / CEPHCIS-UNAM

Mesoamerican cultures, as part of their funerary customs, typically deposited the dead in their tombs and graves with an abundance of ceramics and a diversity of other materials. As archaeological evidence, these deposits can tell us a great deal about the former lives of the interred and in particular indicate their belief in the afterlife and the supernatural transit of material wealth from one world to the next. Funerary remains also speak to the needs of the living—those who honour their ancestors with earthly offerings and strive to ensure a positive disposition toward their kin. The relationship between families and their ancestors is crucial, and can help us comprehend the overall significance of grave goods and their corresponding cults as well as the spaces occupied by the dead and by the living in bereavement.

One of the most remarkable places to observe the veneration of the dead is in Zapotec interments: dynamic deposits often accumulated over centuries that evidence group lineage and generational variation. A central element in this funerary context are Zapotec urns. These ceramic forms, consisting of a vessel and an applied effigy, are documented in the archaeological record from 300 BCE to 800 CE and constitute an outstanding hallmark of this civilization. With few exceptions, these urns are found principally in the Central Valleys of the state of Oaxaca, Mexico. The study of these elaborate and complex forms opens up a window from which we can peer upon the social and religious practices of ancient Zapotec culture over a millennium. Crafted by skilled artisans, the urns can also be appreciated for their aesthetic qualities.

For almost a century, the word “urn” has been the standard nomenclature for these objects, even though the ancient Zapotec did not incinerate their dead and archaeologists have found no evidence that the vessels ever contained human remains. Nonetheless, the historical term is still used and here will

be used interchangeably with "effigy vessel." Zapotec urns are made from a diversity of ceramic pastes, but the majority of the wares were formed with fine brown clay that turns light to dark grey when fired. Other materials, such as stone and wood, were used to make effigies that closely resembled their ceramic homologue, but the clay urns constitute 99% of the known corpus (Sellen 2007, 27–28).

The urns continue to present questions for scholars: What do the effigies represent? How can we explain the great variability that exists among the forms? What is the function of the attached vessel? In recent years a growing body of archaeological evidence and advances in linguistic studies, epigraphy, and iconography have increased our fund of knowledge and provided answers to these questions. There is now a broad consensus that the objects are linked to ancestor veneration.

The Archaeological Context: Zapotec Tombs and Graves

The boundaries of the modern state of Oaxaca encompass a geographic and climatic diversity, from humid coastal regions to significantly colder and drier highlands. In this setting of mountains and valleys, peoples from cultures such as the Zapotec, Mixtec, Chinantec, and Mixe have lived and died for centuries, resulting in a rich archaeological heritage evidenced largely by human remains and ceramics. Among the vast array of ceramic forms found in Oaxaca, the distinctive effigy urns are exclusive to the Zapotec (Caso and Bernal 1952, 9) and are an important diagnostic tool for identifying pockets of *Beni Zaa* culture beyond the confines of the state. For example, the urns have been found 500 kilometres to the north, in the Central Mexican Plateau, in places such as Teotihuacan (Rattray 1992; Urcid 2004) and Calixtlahuaca (Smith and Lind 2005). The map in figure 1 identifies some of the more significant pre-Hispanic sites in the Central Valleys of Oaxaca, and the insert map identifies the site of Teotihuacan where these objects have been found.

The urns were used in two principal contexts: the great majority as objects destined for internment with the dead in the framework of a complex funerary cult, and a small percentage as offerings dedicated to temples and the erection of stele. In the funerary context they have been found in elaborate tombs—venerable houses of ancestors that physically manifest the economic and political power of the hereditary elites (Urcid 2015: 29)—but also in shallow graves in areas not associated with elite residence, suggesting that the cult traversed socio-economic boundaries (Young 1993). Typically, Zapotec tombs are cruciform structures built under residences that often included wall niches where urns and other ceramic forms could be placed (Figure 2); the urns were also positioned on the floor of the tomb, in front of the entrance, and on the roof of the structure. The archaeological evidence suggests that the effigies needed to be in proximity to the interred, but not necessarily associated with a specific individual.

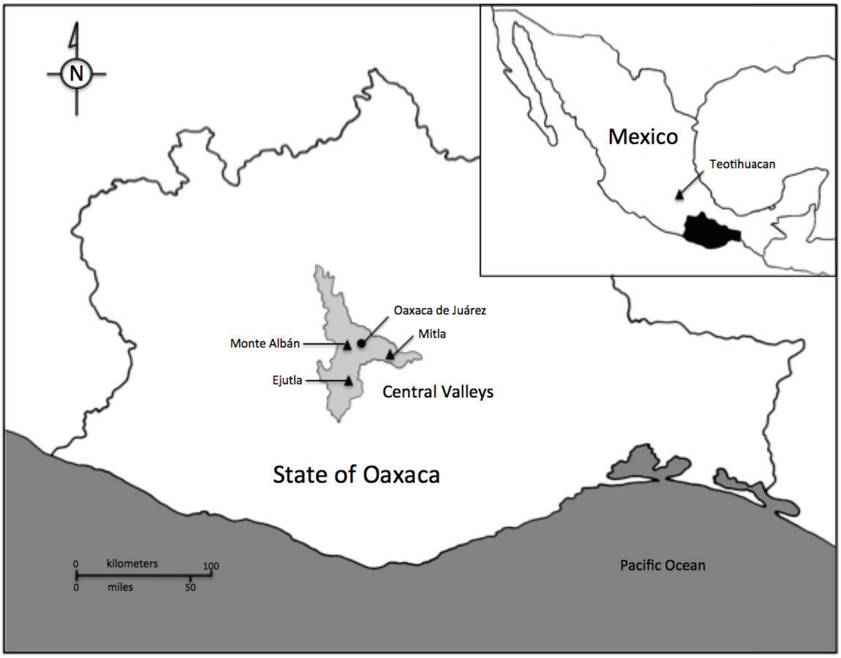


Figure 1: Map of the state of Oaxaca, Mexico, and major archaeological sites.

Figure 2: Niche above tomb entrance with three urns. Tomb 5, Cuilapan, Oaxaca. Photo by Marshall H. Saville, 1899. Archives of the American Museum of Natural History, New York.

Many of these artefacts—and most notably the urns with iconography representing the numen known as lightening, or *Cociyo* in Zapotec—were created in sets of four or five, a reference to the a quadripartite concept of the cosmos, four corners and a centre (Figure 3. See also Chapter 2, “A View of the World,” p. 38). Regrettably, few of these sets maintain their integrity having been separated by collectors and, in some cases, museums curators (see Chapter 4, “The Dispersal of Zapotec Urn Sets,” p. 94).

As in other parts of Mesoamerica, the graves of the Zapotec elite can be generally identified because persons of status were buried with what were considered high-value materials, such as a variety of ceramics, animal bones, precious stones, and shells. These tomb deposits are highly dynamic in nature: when a tomb was opened, the remains of the previous interment, as well as the offerings to the deceased—urns and other ceramic assemblages such as plates, cups, and incense burners—were often moved aside to make room for a new cadaver and additional offerings (Caso 1934, 7). The occasional movement of materials in the burial chamber means that the urns would have undergone changes in position and probably even substantial wear and damage. So while archaeologists have found urns completely intact, others are missing parts

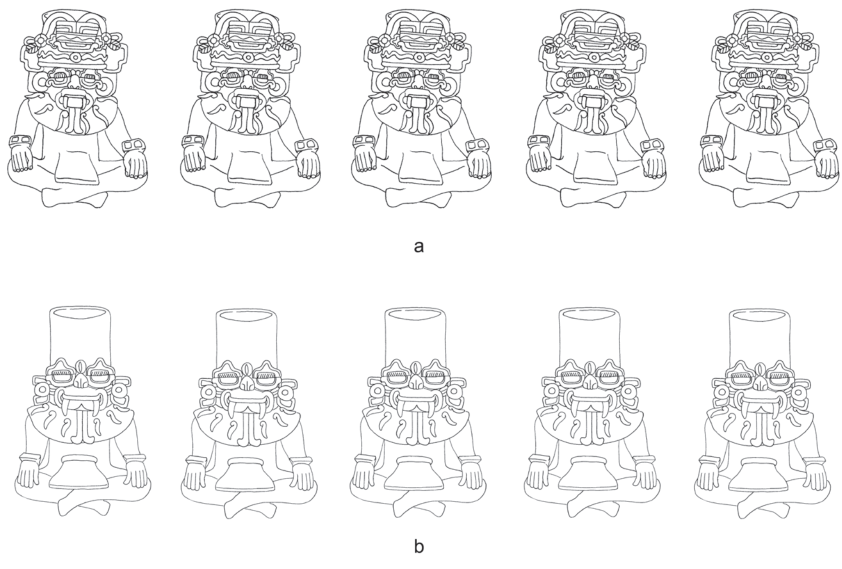


Figure 3: Two sets of five Cociyo vessels at the Saint Louis Museum of Art, Morton D. May Collection: (a) Cat. 249:1978 a-e; (b) Cat. 250:1978 a-e.

HOW TO MAKE A ZAPOTEC URN

For more than a thousand years the fundamental structure of a Zapotec urn consisted of a cylinder with an effigy attached. The cylinder is constructed using a combination of hand-building methods in ceramics, including the concentric ring method (not spiral coiling as in the Southwest of the United States) where a vessel is constructed from thick strips of clay that are joined and then pinched and patted into the desired shape; and moulding, where a slab of clay is pressed over or into a prepared mould to obtain the form. These methods are still in use by Oaxacan potters and are evident in ceramics from the Formative period (Payne 1994, 9–11), from 1500 BCE to 250 CE when certain cultural traits such as large-scale monumental architecture, cities and writing began to develop.

Box 1.1: Typical structure of a Zapotec effigy vessel. Royal Ontario Museum, Cat. HM 346.

Box 1.2: Zapotec potter from San Bartolo Coyotepec, Oaxaca, circa 1910. Photo courtesy the Ibero American Institute, Seler Archive.

Flattening the clay to prepare it for the mould is similar to the process of making a tortilla: a little ash is spread upon a flat stone so the clay will not stick, and grasping a mushroom-shaped tool made of ceramic (*azotadora*) the potter pounds out the clay to the desired thickness and shape (Housten and Carson Wainer 1971, 3–4). Pressing a pre-fired shape into wet clay, otherwise known as stamping, is a similar technique for creating smaller objects such as glyphs and adornments on effigy vessels. In the ROM's collection there is an ancient ear spool stamp that was probably used for this purpose.

Over time the ancient Zapotec experimented with different ways of creating the vessel–effigy structure. For stability and to reduce weight, two cone-shaped vessels would be connected at their bases; some standing figures would "carry" the vessel on their backs. Large pieces were often made of two separate parts, torso and legs, and smaller vessels would have lips added to the border of the cylinder so that they could be easily picked up. In complex effigies with multiple levels of detail, thin strips of clay were used behind the figure to support the overhanging peripheral elements that often were very wide and heavy.

The effigy vessels were designed to be seen from the front, and in very few examples do we find any elaborate decoration on the back (Shaplin 1975, 43). The complexity of the effigy varied greatly and changed over time with the integration of new techniques and innovations, affecting its overall size and the complexity of its iconographic features. In terms of size, effigy vessels can range from 15 centimetres to over a metre high. Making such large objects—and not one, but often four or five identical pieces—required large and deep kilns. Recent archaeological investigations have discovered pre-Hispanic kilns near tomb sites, indicating that some wares were fired in close proximity to where they were ultimately interred. The kilns, stone or adobe circles that have a lower entrance for fuel, are constructed with three central arches to support the ceramics. Kilns of this type can still be seen in communities throughout the state.

Box 1.3: Ancient clay stamp for fabricating ear spools on Zapotec urns. Royal Ontario Museum, Cat. 917.4.137.

Box 1.4: Constructing a kiln in Atzompa, Oaxaca. Photo by the author.

and are fragmented, suggesting that they were used either *in situ* or perhaps in a domestic context long before their deposition in a funerary setting. For example, an urn in the ROM's collection, with the walls of the supporting vessel broken off, shows vestiges of white cement along edges of the break, probably a result of having been mortared into a wall or a niche in antiquity (Figure 4). The urn fragments retrieved from tomb contexts often depict parts of bodies (such as arms, legs, hands and feet) or clothing (such as capes, loincloths and headdresses), but the effigy faces—perhaps the most important feature—are typically absent, and may have been removed in ancient times (Lind and Urcid 2010, 194).

Figure 4: Profile of seated female effigy, Royal Ontario Museum, Cat. 917.4.63.

The Evolution of the Urns and their Chronology

Over their one-thousand-year history, Zapotec effigy vessels have changed in form and in style, from simple and elegant to more elaborate and mass-produced wares. The variations in materials, style, and iconographic attributes allow us to peg the effigy vessels, with more or less accuracy, to five ceramic phases that were defined by Mexican archaeologists between 1931 and 1958 (Caso et al. 1967) and then significantly refined by later scholars who provided new evidence with the aid of radiocarbon dates enabling a more precise anchoring of artefacts within the sequence (Blanton 1978; Drennan 1983; Flannery and Marcus 1990; Kowalewski et al. 1978; Lind 1994; Markens 2004; Martínez López et al. 2000; Paddock et al. 1968; Paddock 1983; Winter 1989, 1997). To refer to the ceramic phases that correspond to the urn's developmental stages most working archaeologists use the terms proposed by Lind (1992) (Table 1).

APPROXIMATE DATES	PHASES PROPOSED BY LIND (1991-1992)	EPOCHS PROPOSED BY CASO BERNAL & ACOSTA (1967)
1521 -1600 CE	Convento	Monte Alban V
1200 -1521 CE	Chila	
800 - 1200 CE	Liobaa	
600 - 800 CE	Xoo	Monte Alban IIIb-IV
500 - 600 CE	Peche	Monte Alban IIIa
350 - 500 CE	Pitao	
200- 350 CE	Tani	Transition II-IIIa
100 BCE-200 CE	Niza	Monte Alban II
300 - 100 BCE	Pe	Monte Alban Ic Monte Alban Ib Monte Alban Ia
600 - 300 BCE	Daniban	

Table 1: Ceramic phases for Oaxaca. Shaded area shows the phases that correspond to the phenomena of the effigy vessels.

Comparatively, the early urns (300 BCE to 200 CE) stand out for their technical sophistication and decorative vitality. Manufactured from fine-grained clay that was hard-baked to a light grey, the effigies protrude from one side of the vessel, and in some examples the appendages of the figure are lightly incised into the clay surface and only the face was modelled in relief. From 200 to 350 CE, the structure begins to take on a more typical form where the fully sculpted figure almost completely hides the attached cylinder. From this point on, strips of clay were positioned between the vessel and the figure to support the fan-like elements of the headdress, resulting in almost theatrical creations; and in the seated effigies, which constitute almost the entire corpus,

the hands are fixed to the knees and the loincloth connects to crossed legs, forming a wide box that steadies the top-heavy urns. From 500 to 800 CE, the iconography of the urns becomes increasingly complex and layered, particularly in the elaborate headdresses. But in the last phase of urn production, the details that were previously hand-modelled with meticulous care were reproduced *en masse,* resulting, for example, in an appreciable decline in quality and a loss of definition in the finer features of the face. The urns produced in the Peche and Xoo phases, generally much larger in size, were manufactured with blackish red-brown clays, then also fired to a light grey (note that variation in the colour of fired bodies is caused by variation in firing conditions rather than in clay body compositions) (Payne 1970, 4). Soon after 800 CE, the phenomena of the Zapotec urn is extinguished, and presumably a great change occurred in Zapotec ritual practice.

Despite modifications in production methods, the overall iconography of the urns remained highly conservative and specific themes were repeated throughout the ages. Certain details in style and form allow us to identify trends. For example: early *Cociyo* urns started out as simple figures with masks and conical hats, but significant changes occurred in the Tani phase (200–350 CE), where effigies sported lampshade-style headdresses with prominent glyphs. In the Pitao phase (350–500 CE) a ruffled collar and cape decorated with the glyph for raindrops is added, and fangs, often separated by a plaque, protrude in front of the mouth. In the later phases (Peche 500–600 CE and Xoo 600–800 CE), the *Cociyo* urns are much more standardized, and gone are the ruffled collars, capes, and prominent teeth of earlier times (Figure 5).

Figure 5: Development of Cociyo effigy vessels over a millennium.

Uncovering the Meaning of the Urns

A common practice among Mesoamerican cultures was to deposit clay effigies in their burial sites, and the diversity of figures (anthropomorphic and zoomorphic) from different contexts, horizons, and cultures has given rise to a number of interpretative frameworks. Scott (1987, 14) summarized three interpretations currently in use in the mainstream literature: 1) that the figures represent deities; 2) that they represent participants in rituals, sometimes including deity–impersonators; and 3) that they represent shamanic spirits. Zapotec urns, broadly speaking, have been interpreted according to this framework.

Throughout the nineteenth century and the first half of the twentieth century there was little archaeological knowledge to support anything other than idle speculation regarding the meaning of Zapotec effigy vessels. The situation changed dramatically as a result of controlled excavations in Oaxaca that began in the 1930s, spearheaded by the Mexican archaeologists Alfonso Caso and Ignacio Bernal. In their seminal work, *Urnas de Oaxaca* (1952), the authors presented the view that the effigies represented a diverse pantheon of Zapotec gods and goddesses. Many studies and catalogues produced after Caso and Bernal slavishly followed this initial premise (see for example Boos 1964, 1966) until a new theory was introduced.

In the late seventies, Joyce Marcus reinterpreted the effigy vessels as royal ancestors impersonating supernatural entities (Marcus 1978, 1983, 1998; Marcus and Flannery 1996), marking a sharp break with the earlier paradigm of deity complexes. Marcus's research consistently questioned the existence of deities among the ancient Zapotec, preferring instead an animistic model that emphasizes the spirit world and the presence of supernaturals. While Marcus's paradigm of the effigies as mortals instead of gods has been invaluable, the iconographic variability of the vast corpus remained unexplained, and as a result many researchers continued to use the typological classification presented by Caso and Bernal.

My own research has shown that the deity model should be modified rather than completely discarded. The deities are recognizable for attributes, such as the open maw of a mythical being, that are linked to the Zapotec ritual calendar of 260 days, the sacred count that ordered their ritual and religious life. Many of the anthropomorphic and zoomorphic entities mentioned in the Zapotec calendar are similar to those known in other Mesoamerican cultures that are considered fundamentally pantheistic (for example, the Aztec and the Maya), and taking into account cultural continuity it is probable that the Zapotec also had a pantheon of gods (Sellen 2002a). Building upon the study of Javier Urcid (2001) that asserted a link between the iconicity of some of the calendar glyphs and attributes found on effigy vessels, I was able to correlate nine calendar deities with the forms displayed on the ceramic figures. Furthermore, the multiplicity of deity masks and costumes found on the effigies, and the fact that

a few mask types are interchangeable, supports the view that they are worn by people, probably ancestors as Marcus surmised. Thus, these hypothesized ancestors are impersonating deities represented in the ancient calendar, not supernaturals as Marcus suggests, a position that favours Caso and Bernal's pantheistic interpretation over an animistic approach.

If the human figures attached to the vessels are indeed ancestors, they are represented in a generic way, with a physiognomy that is as standardized as it is idealized and with uniform facial features that do not permit us to discern gender. However, the attire worn by these individuals does reflect the way they lived and is key to understanding not only their status and role in society but also their gender: females, with braided hair tied up into a circular headdress, wore garments known as *quechquemitl* (a type of poncho or shawl that hangs off the shoulders); males, with their hair tied in a knot or with an elaborate headdress, wore a simple loincloth and sometimes a decorated cape. Postures also separated women from men, the latter sitting on their knees and the former sitting cross-legged. An in-depth analysis of the garments and other accoutrements on the effigies suggests that the persons depicted are priests or royalty from the upper echelons (Sellen 2002b).

Approximately 5% of the known corpus of urns integrate into their design day glyphs associated with numbers; their placement depended on the creativity of the artisan but generally they appear in the headdress (Figure 6). These glyphs correspond to the ancient calendar, a 260-day cycle that paired thirteen numbers with twenty day names. For example, the first day in the calendar was "1 *chilla* (alligator)." A circle with a *U* shape inside conveyed the number 1, and a type of bound bar the number 5 (Figure 7). In the case of HM 1953 and a few other urns, however, the bar was omitted and the number 5 was expressed using a series of five dots (see Figure 6a). Each day glyph was presided over by a god and many had associations with specific natural phenomena. The ritual 260-day cycle was used for divination purposes, while another 360-day cycle was used to keep track of the solar year. In many Mesoamerican cultures the date of birth was also used to name people, and from historical sources we know that the ancient Zapotec named their children according to the day they were born. So the glyphs we see on the urns that are accompanied by numbers represent the name of an individual (Sellen 2007).

In the case of HM 1953 we have only part of the name, the coefficient 5; the day glyph is missing. In its place another, unrelated motif, was attached to the break, presumably by someone other than the ancient potter who would have understood how the calendar worked. The motif used to replace the day glyph is an ancient form, and shows a row of feathers and a set of "eyes," the Zapotec convention for a bird's wing. A common attribute of effigy vessels are the many different species of birds that can be seen in the headdresses, and in general these are represented with their wings prominently displayed: sometimes as a frontal view showing both wings, or in profile, with only one wing present (Figure 8).

a b c

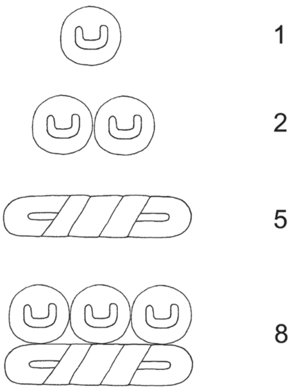


Figure 6 (top): Effigy vessels with day glyphs and coefficients: a) 5 *Loo*, ruler or lord, Royal Ontario Museum, Cat. 917.4.133; b) 4 *Chilla*, alligator, Smithsonian Institution, Cat. 214979; c) 4 *Loo*, eye, Museo Nacional de Antropología, C at. 6-6592.

Figure 7 (middle): Ancient Zapotec numbering system.

Figure 8 (bottom): The iconography of bird wings on Zapotec effigy vessels, a) Janssen collection, Musées Royaux d'Árt et d'Histoire; b) Sotheby's catalogue, 2 May 1990, figure 207; c) Ethnologisches Museum, Berlin, IV Ca. 24097; d) Museum für Volkerkunde, Viena, Cat. 6087.

a b c d

Apart from clothing, adornments, and calendar glyphs, many of the visual attributes displayed on Zapotec effigy vessels focus on representations of the maize plant (kernels, sprouts, and cobs) and its growth cycle, as well as associated motifs, such as a cornfield glyph or water symbols. There is also evidence from effigy vessels, historical sources, and ethnographic studies that the Zapotec offered animal and human blood in rituals related to maize, a practice widely documented for other ancient and present-day Mesoamerican communities, and a ritual fundamental to ancient Zapotec ideology that is linked to the founding of their most important city: Monte Albán (Joyce 2000). Maize and blood were central elements in ancient Zapotec religious practices and were related conceptually. The iconographic information gleaned from studies of effigy vessels suggests that one of the major themes in the ancient representations was fertility, underscored by a sacred pact between humans and the gods associated with sustaining the growth cycle of maize (Sellen 2011). The element that connected sacred beings with humans was blood—the vital liquid that stimulated fertility and needed to be spilled to ensure the continuity of life. Furthermore, a handful of urns have been found with the remnants of blood ritual inside their vessels: maize kernels, jadeite beads, bird bones, and obsidian blades.

The ancient Zapotec were one of the pre-Columbian cultures that developed maize into the versatile food that we know today, and frequently represented it in their myths and artistic expression. The plant was more than a staple crop—it also represented a model of their world, and served as a symbol of the four corners and as the central *axis mundi*, a conduit of divine power (Taube 2000, 328). In that imagined world, the great lightening god *Cociyo* was thought to reside on the four corners and control forces both benevolent and destructive to the Zapotec's crops, and to the life-sustaining maize in particular. It is no surprise then that effigies of this numen are the most common in the corpus, and that they were often made in series, reflecting *Cociyo*'s quadripartite character. One way to understand the relationship between mortals and their gods is through the eyes of a sixteenth-century Spanish priest, who used the Holy Inquisition against a Mixtec man named don Francisco to document his return to his idolatrous roots:

> … as it did not rain, don Francisco sent for the priests to go into the forest and make charcoal, and grind it into dust for ink; don Francisco stripped naked, painted his body inky black and said: now I am not Christian, but who I used to be. He sacrificed blood from his ears and made smoke with incense, and sent for many quails that he also sacrificed. Then he called on the devil… (Sepúlveda y Herrera 1999, 170).

As it was then, we can also imagine further back to the ancient *Beni Zaa*, in crisis over the lack of rain and imminent failure of their crops, calling upon their ancestors to intercede with the formidable lightening god. They created ceramic

effigies that referenced not only *Cociyo*, but also named their sacred ancestors. Centuries later, one of those effigies came to the Royal Ontario Museum and waited patiently for its story to be told.

COLOURFUL URNS

Effigy vessels with applications of colour are common and in most cases this pigment is red, but there are many examples in polychrome, some spectacular. The paint on Zapotec urns is powdery and friable, and once the vessels are unearthed and in contact with air these unstable pigments tend to disintegrate; and while not visible to the naked eye, traces of pigment can be found on artefacts that have been in museums collections for over a century. Most of the polychrome urns retrieved from controlled excavations indicate that the paint was applied directly on the surface of the fired clay body in the form of a wash with an organic binder, however there are a few effigies with vestiges of white pigment, perhaps a stucco base for other colours (Alderson 2002: 148). In general the pigments, mixed in a slur of unfired clay, were brushed over the entirety of the effigy, or applied selectively, either to the face, the central area of the headdress, or to a significant feature, such as a glyph. Repainting of the urns seems to have been a common practice, in line with the reuse of these objects in different funerary contexts.

While systematic research on the chemical composition of these colours is still in its infancy, two studies using a scanning electron microscope with energy dispersive spectroscopy (SEM-EDS), demonstrated similar results (Alderson 2002; Robles *et al.* 2014): For red pigments, by far the most common colour, researchers analyzed urns excavated from the site of Atzompa in 2012, and found traces of cinnabar, a mercury based element, mixed with red earth or iron oxide that has its origin in hematite. They noted that the differing tonalities and intensity of the red depended on the quantity of cinnabar present in the hematite mix (Robles *et al.* 2014: 49); analyzing urns excavated from the site of Xoxocotlán in 1899, Alderson (2002: 149-150) found the same two elements, and noted that hematite, the more common mineral, was widely used on the large objects in the form of a wash, while the rarer cinnabar was sparingly applied to an effigy that was smaller and exquisitely made, suggesting that the ancient Zapotec held this mineral in high regard. Finally, an unpublished study of six urns at the ROM, also using SEM-EDS, found iron oxide on all of the objects; cinnabar was not present. One urn tested for titanium, a ubiquitous element in white paint (Ramick, personal communication, 2004); this data coincided with a thermoluminescense test that determined the urn to be a twentieth century creation.

Studies of a stunning polychrome urn recently unearthed in Atzompa, show that the palette of colours included a yellow rich in iron oxide and a green produced from veszelyite, a copper-zinc phosphate that results in a deep blue-green hue. Furthermore, an urn in the collections of The Museum of Natural History in New York, has traces of the famed Maya blue, a composite of organic and inorganic substances (Alderson 2002: 150). This object was documented in the nineteenth century with a watercolour probably soon after it was excavated, and a comparison of the way the urn looks today with the sketch shows how much pigment has been lost (Box 2.1).

Box 2.1: Polychrome effigy vessel, Museum of Natural History, New York, Cat. 30.2/6099, compared with a watercolour sketch of same object by Eduard Seler, circa 1888. Photo courtesy the Ibero American Institute, Seler Archive.

References Cited

Alderson, Samantha. 2002. "A Technological Study of the Painted Surfaces of Zapotec Urns from Xoxocotlán." In *AIC Objects Specialty Group Postprints*, Vol. 9, compiled by Virginia Greene and Patricia Griffin, 146–60. The American Institute for Conservation of Historic and Artistic Works.

Blanton, Richard. 1978. *Monte Alban: Settlement Patterns at the Ancient Zapotec Capital*. New York: Academic Press.

Boos, Frank H. 1964. Vol. 1. *Las urnas zapotecas en el Museo Real de Ontario. Corpus Antiquitatum Americanensium*.

Mexico: Instituto Nacional de Antropología e Historia y Unión Académique Internationale.

——— 1966. Vol. 2. *Las urnas zapotecas en el Museo Frissell. Corpus Antiquitatum Americanensium*. Mexico: Instituto Nacional de Antropología e Historia y Unión Académique Internationale.

——— 1968. Vol. 3. *Colecciones Leigh, Museo Frissell de Arte Zapoteca, Smithsonian Institution, y otras*. *Corpus Antiquitatum Americanensium*. Mexico: Instituto Nacional de Antropología e Historia y Unión Académique Internationale.

——— 1966. *The Ceramic Sculptures of Ancient Oaxaca*. A.S. Barnes, New York.

Caso, Alfonso. 1934. *Las tumbas de Monte Albán, Trabajo presentado en el Primer Congreso Mexicano de Historia, Oaxaca*. Mexico: Publicaciones del Museo Nacional, Secretaría de Educación Pública.

Caso, Alfonso and Ignacio Bernal. 1952. *Urnas de Oaxaca*, Instituto Nacional de Antropología e Historia. Memoria no. 2. Mexico.

Caso, Alfonso, Ignacio Bernal and Jorge R. Acosta. 1967. *La cerámica de Monte Albán*. Memorias del Instituto Nacional de Antropología e Historia, No. 13, México D.F.

Drennan, Robert D. 1983. Appendix: Radiocarbon Dates from the Oaxaca Region. In *The Cloud People: Divergent Evolution of the Zapotec and Mixtec Civilizations*, edited by Kent V. Flannery and Joyce Marcus, 363–70. Academic Press, New York.

Flannery, Kent, and Joyce Marcus. 1990. Science and Science Fiction in Postclassic Oaxaca, Or "Yes, Virginia There is a Monte Albán IV." *Debating Oaxaca Archaeology*, edited by Joyce Marcus, 191–205. Anthropological Papers no. 84, Museum of Anthropology, University of Michigan, Ann Arbor.

Houston, Margaret, and Judith Carson Wainer. 1971. Pottery-Making Tools from the Valley and Coast of Oaxaca. *Bulletin of Oaxaca Studies*, no. 36, 1–7. Mitla, Oaxaca: Museo Frissell de Arte Zapoteca.

Joyce, Arthur A. 2000. The Founding of Monte Albán: Sacred Propositions and SocialPractices. In *Agency in Archaeology*, edited by Marcia-Anne Dobres and John Robb, 71–91. Routledge, London.

Kowalewski, Stephen A., Charles Spencer, and Elsa Redmond. 1978. Description of Ceramic Categories (Appendix II). In *Monte Albán Settlement Patterns at the Ancient Zapotec Capital*, edited by Richard E. Blanton. Academic Press, New York.

Lind, Michael D. 1992. Unos problemas con la cronología de Monte Albán y una nueva serie de nombres para las fases. *Notas Mesoamericanas*. No. 13: 177–92.

——— 1994. Monte Albán y el Valle de Oaxaca durante la fase Xoo. In *MonteAlbán: Estudios recientes*, edited by MarcusWinter, pp. 99–111. Contribución

del Proyecto Especial Monte Albán 1992–1994, vol. 2.

Lind, Michael D. and Javier Urcid. 2010. *The Lords of Lambityeco. Political Evolution in the Valley of Oaxaca during the Xoo Phase*. Boulder: University of Colorado Press.

Marcus, Joyce. 1978. Archaeology and Religion: A Comparison of the Zapotec and Maya. *World Archaeology* 10 (2): 172–91. Routledge and Kegan Paul Ltd., London.

——— 1983. Rethinking The Zapotec Urn. In *The Cloud People: Divergent Evolution of the Zapotec and Mixtec Civilizations*, edited by Kent V. Flannery and Joyce Marcus, 144–48. New York, Academic Press.

——— 1998. *Women's Ritual in Formative Oaxaca: Figurine Making, Divination, Death and the Ancestors*. Memoirs of the Museum of Anthropology no. 33. Ann Arbor, University of Michigan.

Marcus, Joyce and Kent Flannery. 1996. *Zapotec Civilization*. New York, Thames and Hudson.

Martínez López, Cira, Robert Markens, Marcus Winter and Michael D. Lind. 2000. *Cerámica de la fase Xoo (época Monte Albán IIIB-IV) del valle de Oaxaca*. Contribución No. 8 del Proyecto Especial Monte Albán 1992–1994. Centro INAH, Oaxaca.

Markens, Robert. 2004. *Ceramic Chronology in the Valley of Oaxaca during the Late Classic Period (A.D. 500-800) and the Organization of Ceramic Production*. Unpublished masters thesis on file at the Department of Anthropology, Brandeis University, Waltham, Massachusetts.

Paddock, John. 1983. Lambityeco. In *The Cloud People: Divergent Evolution of the Zapotec and Mixtec Civilizations*, edited by Kent V. Flannery and Joyce Marcus, 186–88. New York, Academic Press.

Paddock, John, Joseph Mogor, and Michael D. Lind. 1968. Lambityeco Tomb 2: A preliminary report. *Boletín de Estudios Oaxaqueños*. No. 25. Museo Frissell de Arte Zapoteca.

Payne, William O. 1970. A potter's analysis of the pottery from Lambityeco tomb 2, *Bulletin of Oaxaca Studies*, no. 29, pp. 1–8. Mitla, Oaxaca: Museo Frissell de Arte Zapoteca.

——— 1994. The Raw Materials and Pottery-Making Techniques of Early Formative Oaxaca: An Introduction. In *Prehistory and Human Ecology of the Valley of Oaxaca*, edited by Kent V. Flannery and Joyce Marcus, 7–20, Vol. 10. Memoirs of the Museum of Anthropology, University of Michigan, No. 27, Ann Arbor.

Rattray, Evelyn C. 1992. *The Oaxaca Barrio at Teotihuacan*. Monografías Mesoamericanas, No. 1. Instituto de Estudios Avanzados de la Universidad de las Américas Puebla, Cholula.

Robles García, Nelly, Pacheo Arias, Leobardo D, and Mireya Olvera Sánchez. 2014. "El Señor Ocho Temblor y la Señora Agua, dos urnas zapotecas de elite en Atzompa, Oaxaca: iconografía y conservación," *Arqueología* 49: 120–33.

Scott, John Frederik. 1987. The Role of Mesoamerican Funerary Figures. In *Arte Funerario: Coloquio Internacional de Historia de Arte* (Beatriz de la Fuente, ed.): Vol. II, 7–16. Mexico City, UNAM.

Sellen, Adam T. 2002a. Storm-God Impersonators from Ancient Oaxaca. *Ancient Mesoamerica* 13: 2–19.

——— 2002b. "Images of Deified Kings from the Valley of Oaxaca", *Quaderni di Thule,* I: 233- 237, Atti del XXIII Convegno Internazionale di Americanistica, Perugia, 4, 5 y 6 de mayo de 2001, Argo Editore, Perugia.

——— 2007. *El Cielo compartido: las vasijas efigie zapotecas*, serie Monografías 4, Centro Peninsular en Humanidades y Ciencias Sociales, Merida, Mexico.

——— 2011. "Sowing the Blood with the Corn: Zapotec Effigy Vessels and Agricultural Ritual," *Ancient Mesoamerica* 22: 71–89.

Sepúlveda y Herrera, María Teresa. 1999. *Procesos por idolatría al cacique, gobernadores y sacerdotes de Yanhuitlán 1544–1546*. Serie Etnohistoria, Instituto Nacional de Antropología e Historia, Mexico.

Shaplin, Philippa D. 1975. "An Introduction to the Stylistic Study of Oaxacan Urns." Unpublished masters thesis on file at Wellesley College Department of Art, Boston.

Smith, Michael E., and Michael D. Lind. 2005. Xoo-Phase Ceramics from Oaxaca Found at Calixtlahuaca in Central Mexico. *Ancient Mesoamerica* 16: 169–77.

Taube, Karl. 2000. Lightning Celts and Corn Fetishes: The Formative Olmec and the Development of Maize Symbolism in Mesoamerica and the American Southwest. In *Olmec Art and Archaeology in Mesoamerica*, edited by John E. Clark and Mary E. Pye, 297–337. Studies in the History of Art no. 58, National Gallery of Art, Washington DC.

Urcid Serrano, Javier. 2001. *Zapotec Hieroglyphic Writing*. Studies in Pre-Columbian Art and Archaeology. No. 34. Dumbarton Oaks, Washington DC.

——— 2004. Las urnas del barrio zapoteca de Teotihuacan, *Arqueología Mexicana*, 64 (II): 54–7.

——— 2005. Zapotec Scribal Tradition: Knowledge, Memory, and Society in Ancient Oaxaca. URL: www.famsi.org/zapotecwriting/

——— 2015. Una casa de ancestros reales en el Cerro de Campana, Oaxaca, *Arqueología Mexicana*, 132 (XXII): 28–35.

Winter, Marcus. 1989. From Classic to Post-Classic in Pre-Hispanic Oaxaca. In *Mesoamérica after the decline of Teotihuacan, A.D. 700-900*, edited by Richard A. Diehl and Janet Berlo, 123–30, Dumbarton Oaks Research Library and Collection, Washington DC.

——— 1997. Classic to Postclassic in the Valley of Oaxaca: A View from Monte Albán. *U Mut Maya* VI: 21–42. Bayside.

Young, Penny. 1993. *The Jalieza Urns and Clasic-Postclassic Period Community Oraganization in Oaxaca, Mexico*. Master's Thesis, McMaster University, Canada.


CAST OF HEAD OF COYOLXAUHQUI

CHAPTER 4

From Grave to Museum: A History of HM 1953 in Collections

ADAM T. SELLEN / CEPHCIS-UNAM
APRIL HAWKINS / ROYAL ONTARIO MUSEUM

Museums and their collections often conjure up images of exhibition cases and dusty storerooms brimming with three-dimensional objects—mainly ceramics—that were excavated long ago by individuals who knew little about the rigors of current archaeological practice. While it is generally true that older archaeological collections were not systematically excavated, we tend to overlook the wealth of associated information that documented, often in surprising detail, how and where these troves of objects were retrieved. In this chapter we analyze a wide range of historical documentation generated by nineteenth-century amateur archaeologists, art collectors, and museums. The data we analyze not only provide us with a rich source of information for the focus of this book—a Zapotec urn with a complex story to tell—but also continue to inform much-needed research into the history of museum collections. By stitching together the fragmentary record, we hope to shed light on HM 1953's biography and how it came to rest at the ROM. Investigating the origin and history of an object is known in the art and antiquities world as provenance, a method that is employed especially when there are doubts about legality or authenticity.

The ancient ceramic effigy analyzed in this book was created sometime during the fourth or fifth century. On an Old World timeline, the object dates to around the decline of the Roman Empire and the Mongol invasion of the West. As sacred offerings, Zapotec effigy vessels—often produced in sets of four or five matching pieces—were meant to remain buried with the dead. Yet the unearthing of Oaxaca's magnificent pre-Hispanic tombs and artefacts in the late eighteenth century gave rise to a voracious collecting spree. Early antiquarians particularly desired the impressive Zapotec urns for their cabinets of curiosities. Collecting accelerated in the second half of the nineteenth century during an

era of positivist science characterized by spectacular finds, collection-forming, and museum-building. Urns and their associated ceramic assemblages were channelled into vast private collections, both Mexican and foreign. A staggering number of objects were dispersed (see The Dispersal of Zapotec Urn Sets below), and the records of their retrieval and the debates they inspired languished in obscure publications or dusty archives. The fragments of documentation that survive this antiquarian pursuit illustrate a remarkable moment in archaeological exploration, as concepts and typologies that are now customary were first taking shape, and as debates ensued about the origins and significance of the chaotic material culture that seemed to be everywhere beneath the Oaxacan soil (Sellen 2015a).

THE DISPERSAL OF ZAPOTEC URN SETS

Zapotec urns, especially those with *Cociyo* imagery, were often produced in matching sets of four or five (see Chapters 2 and 3), yet in a museum context it is rare to see these artefacts exhibited together. In fact, few museums possess complete matched sets of urns. The reason has to do with how they have been collected. In the nineteenth century, when many collectors divested their collections, they often divided up the sets, because individual objects would fetch more money. The precarious archaeological context of the urns often resulted in one or more of the objects being damaged. Generally one or more objects in a set were in better shape than the others and these could be sold at a premium. Also, when sets were excavated under a *partage* agreement with another country (where foreign institutions would pay the costs of an excavation for a percentage of the artefacts discovered) the matching urns were considered "duplicates" and distributed among different museums. Even Mexico's National Museum has taken this position and allocated urns from excavated sets to bolster collections in smaller museums around the country. The problem with this approach is that it violates the character of the artefacts, which should be considered together, as a whole, from the perspective of core beliefs in indigenous world view and ritual practice.

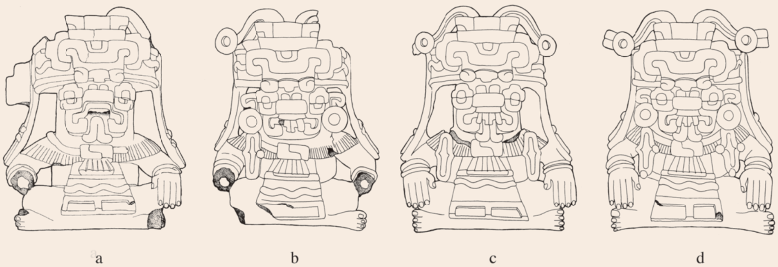
Reconstituting these sets is a difficult task. Many of the individual urns have followed circuitous routes between buyers and institutions before finally ending up in museums, principally in North America and Europe. An example of this complex history can be seen in a set of four identical ceramic urns that were split up and sold by the Oaxacan collector Manuel Martínez Gracida. In September 1894 he described

Box 1.1: Set of four Cociyo urns flanking a central figure (fourth urn on left not shown). Published in Saville 1899: plate XXII.

Box 1.2: Set of five urns without heads. Marshall H. Saville excavation in Xoxocotlan, Oaxaca, 1899. Published in Saville 1904: 53.

retrieving the group from a tomb in Zaachila, Oaxaca, but almost immediately he sold three of them: two urns went to Lucio Smith, who subsequently shipped them to the United States where they were bought by Edward William Nelson. He later donated them to the Smithsonian Institution; Luis Raynaud obtained one of these three but then sold it to Gustave Bellon of Oaxaca, a collector who shipped his entire collection to Paris. George Gustav Heye then acquired the urn at auction in 1929 for his Museum of the American Indian in Brooklyn (now defunct; its collections were acquired by the Smithsonian Institution). The fourth urn, which was the most complete of the set,

was sold to the German collector Eduard Seler, who in turn sent it to the American Museum of Natural History in New York under a *partage* agreement. In 1929 the New York museum sent it to the Peabody Museum in Boston where it remains today. Thus, by many indirect channels, all the urns belonging to the original set are now in the United States.



Box 1.3
Actual location of four Cociyo urns discovered by Manuel Martínez Gracida in Zaachila, Oaxaca, in 1894: a) Cat. 180086, Smithsonian Collection (NMAI); b-c) Cats. 198426 and 198427, Smithsonian Collection (Dept. of Anthropology); d) Cat. 10609, Peabody Museum, Harvard.

Locating the distinct parts of these sets can be a challenge because museums do not routinely make public all the materials they hold in their storerooms, especially if they are in a fragmented state. In his extensive cataloguing of Zapotec urns, Frank Boos registered some of these orphaned objects and began to make connections (cf. Boos 1964-1968; 1966) and in a more systematic attempt the author of this sidebar produced an online database of effigy vessels (Sellen 2015). Slowly we are reuniting these unfairly orphaned sets with their next of kin, as in the case of HM 1953.

The ancient object at the core of HM 1953 was a product of these late-nineteenth-century excavations, but where is it from? Collectors of this period were typically rigorous in assigning provenance to the objects in their cabinets by adhering labels to them with numerical correspondences to inventory lists (König and Sellen 2015, 404–406). Unfortunately, the label once adhered to HM 1953 below the figure's left knee, evident in early photographs of the piece, either fell off or was removed, so the collector's voice on this question has been silenced, at least for now. Without a solid clue we can only surmise that the urn was probably discovered in a tomb somewhere in the valley of Oaxaca.

With hundreds of urns retrieved from undocumented explorations and lacking secure provenance, many scholars and museum curators assign them by default to Monte Albán, the famous hilltop city located in the middle of the Central Valleys of Oaxaca that was intensively excavated and restored by professional archaeologists from 1935 onward. Prior to this time, amateur archaeologists had limited access to Monte Albán because the lands were privately owned, and so despite the site's proximity to the city of Oaxaca it was largely left untouched: in a photograph taken circa 1900 we can see that Monte Alban's great esplanade was planted with corn and its pyramids were mounds of rubble (Figure 1). In bypassing this important site, the local collectors and their foreign counterparts focused on towns with significant pre-Hispanic centres in the Central Valleys, such as Ejutla, Zaachila, Zimatlan, Xoxocotlán, Etla, and Tlacolula. The massive amounts of ceramics unearthed in this late-nineteenth-century bonanza flowed into private collections and museums, most of it without any form of archaeological documentation; hence our supposition that HM 1953 came from one of those informal excavations.

What we do know is that the ROM's effigy vessel was once part of the collections of the Oaxaca Museum, located in the city's Instituto de Artes y Ciencias. The urn appears in an undated photograph from around the turn of last century, where we can see it rising above other specimens on the top shelf (Figure 2). However, in the same decade the object appears to have entered into the private collection of Constantine Rickards. How is this possible? Caecilie Seler-Sachs, a frequent traveller to Oaxaca during this time, lamented how the

Figure 1: Monte Albán: view from the South. Charles Burlingame Waite photo, circa 1900. ROM archives.

Figure 2: HM 1953 on display in the Oaxaca Museum around the beginning of the twentieth century. Undated photograph from the Archives of the Registrar of Public Monuments and Archaeological Zones, Mexico City, Mexico.

Oaxaca museum received valuable effigy vessels from the state's indigenous communities only to sell the pieces to local collectors (König 2003, 328). While we have no specific evidence that the museum sold HM 1953 to a private collector, we know that archaeological objects migrated from public domains to private ones with much more ease than they do today, and such a transaction could have occurred between the museum and Rickards.

The burst of collecting and scientific inquiry that characterized the end of the nineteenth century ended on a dark note. With many collectors selling their holdings to public museums, and a more rigorous application of the 1897 law that protected pre-Hispanic monuments and artefacts from export to foreign countries without previous congressional approval, there were fewer opportunities to obtain pre-Hispanic materials. The flow of archaeological artefacts into private cabinets slowed substantially, and the type of object desired by collectors changed: they were increasingly less motivated by the empirical knowledge of the earlier era and strove to obtain pre-Hispanic objects such as Zapotec urns for purely aesthetic reasons. Sellen's research, along with that of other scholars, has shown that the demand for these wares soon overtook the supply and a cottage industry peddling fakes emerged in Oaxaca. The forgers responded to the demand in the art market and, consciously or not, to tastes stemming from the growing Expressionist art movement in Europe (Shaplin

Figure 3: Zapotec urns in the salon of William Wonderly, circa 1930. Photo supplied by George Rickards.

and Zimmerman 1978, 47); large, ornate urns with their fantastic pre-Hispanic imagery were strangely suited to the decoration of Victorian-style parlours (Figure 3).

The story of these fakes is still not entirely clear—hardly surprising given the clandestine nature of the endeavour—but what we do know is that hundreds of faux Zapotec urns occupy the exhibition halls and storerooms of almost all the major museums in North America and Europe. Forgeries of pre-Columbian artefacts are everywhere, and their presence in private and public collections has inspired numerous articles, books, and conferences on the subject (Boone Hill 1993; Ekholm 1964; Kelker and Bruhns 2009; Schávelzon 2009; Maclaren Walsh 2005; Mongne 1987, 2000). But perhaps no other type of pre-Columbian artefact has been forged as extensively as the ubiquitous Zapotec urn. The fakes in museum collections have seriously contaminated scholarly and popular works on this ancient culture, frustrating our ability to distinguish pre-Hispanic wares from contemporary creations. A salient example is Paul Shao's 1976 work, *Asiatic Influences in Pre-Columbian Art*, where as part of his argument for pan-Pacific contact he compared two three-headed Zapotec urns to Brahma statues with similar features (Figure 4). Unhappily for Shao, these urns are twentieth-century creations. Of particular importance to us, these spurious statues come from Constantine Rickards, the same collector that supplied the Royal Ontario Museum with HM 1953. His story is an integral part of the urn's history.

Figure 4: Paul Shao's comparison of two Zapotec urns, formerly Rickards collection (left and right), with a brahma statue from India (middle).

The Collector: Constantine Rickards

The earliest documented owner of HM 1953 is Constantine Rickards, a lawyer of English parentage who spent his entire life in Mexico (Figure 5). His father, Constantine Sr., had immigrated to the country in the 1850s and held significant gold and silver mines in the state of Oaxaca. When the elder Rickards passed away in 1905, Constantine Jr. inherited the business and took his place among the elite of Oaxaca. Remarkably English in his demeanour, he served for a number of years as British vice-consul and participated actively in the scientific societies of the day. From an early age he was an avid collector of pre-Hispanic antiquities, butterflies, and stamps, and when his fortunes increased, so did the size of his threefold cabinet. His zeal for archaeology was influenced by distinguished Oaxacan collectors Fernando Sologuren, Francisco Belmar, and Martínez Gracida, who, in the first decade of the twentieth century, sold their grand collections to museums in Mexico and overseas (Sellen 2015a). The younger Rickards, however, was just getting started. In 1907, under dubious circumstances, he obtained a major Mixtec *lienzo*, a painted sheet, 5 feet wide by 15 feet high, that later he called the Codex Rickards (Van Doesburg 1998, 59; Brownstone 2015). And in 1910, at great expense, he self-published a book, *The Ruins of Mexico*, where he highlighted some of the urns in his collection, including the vessel HM 1953 (Figure 6).

Rickards spent lavishly on his collecting habit, belying the reality of his deteriorating finances. His misfortune began in 1906 when a crisis originating in the United States made credit and gold scarce. Coupled with a sharp drop

Figure 5: Constantine George Rickards (1876-1950). ROM archives.

Figure 6: Photograph showing HM 1953 (middle) in Rickards self-published study, *The Ruins of Mexico*, Vol. I, p. 132.

in mineral prices, the crisis paralyzed his mining operation (Chassen 1990, 103–105). With the outbreak of the Mexican Revolution in 1910, the 34-year-old miner–archaeologist was forced to sell his collection of artefacts to remain solvent. We know that in 1911 he tried to sell it to a number of museums, including the National Museum in Mexico City, the American Museum of Natural History in New York, and the ROM. He sent photographs of his collection to all these institutions; the vessel HM 1953 can be seen on the top shelf in some of these pictures, presumably while it was still in his home (Figure 7). Of the ten

5-by-7 photographs in the ROM archives, two are duplicate views and two are views of the collection taken at different times, with dozens of new acquisitions visible on the shelves in the latter photo, most of them large Zapotec urns. This leads us to think that Rickards continued to acquire archaeological materials at a time when his funds were scarce, perhaps in an attempt to obtain a better price for the collection. Furthermore, the urn in Rickards's photographs looks identical to one we observed in an earlier picture from the Oaxaca Museum.

Although there was considerable interest in the collection, a sale did not materialize. Four years later, Rickards's desperation was evident when he again offered it to the Mexican National Museum, but at $40,000 pesos it was almost double the price: 10,000 pesos in silver and the rest to pay the outstanding taxes on his mines. When the museum balked, Rickards quickly modified the deal and stated that he would be satisfied with enough to cover his debt.[1] In the end he lost his mines, and in 1917 was forced to flee the state of Oaxaca in a boxcar, leaving behind most of his assets and a storied life he would never regain. Finally, through a close friend in Mexico City, the American anthropologist and archaeologist Zelia Nuttall, he was able to broker a deal with the Royal Ontario Museum, which had generous funds to acquire new collections thanks to the patronage of the wealthy financier Sir Edmund Walker (Sellen 2004).

The ROM's curator, Charles Trick Currelly, was eager to buy a large collection representing this area of the world. In the spring of 1919 he travelled to Mexico City to inspect the acquisition and planned to return to Canada with his prize, after having secured the export permits. Manuel Gamio, an influential archaeologist who at the time was head of the department of Anthropology under the Secretary of Agriculture and Development, supplied the Canadian curator with a letter stating that it was no problem to take the objects out of the country because they were "duplicates."[2] In this case the meaning of "duplicates" could be ambiguous, but Currelly understood it to mean that the collection was "already represented in the National Museum in Mexico City… duplicated many times over."[3] For the considerable sum of $25,000 Canadian the curator brought home the *lienzo* and part of the ceramic collection; also, several plaster casts received in donation from the Mexican National Museum: three of stone idols, one of the massive head of Coyolxauhqui (Figure 8), and another of a set of panels from the Temple of the Cross, Palenque.

While Gamio had given his permission to export some of the collection, part of the portion sold to the ROM, notably the large ceramic effigies, remained in Mexico City as there was a question whether they could leave the country. The solution was to store them in trunks in the basement of the British Legation, and exporting this material would prove to be a long and difficult task for the ROM. In 1930, five trunks were mistakenly sent as the personal effects of Mrs. Cunard Cummins, wife of the Legation's top diplomat, to a ranch in Tlahualilo, Durango, a small, dusty town in one of Mexico's most northerly states; hoping to find her hats and shoes, she opened the crates to find them crammed with ceramic idols.[4]

Figure 7: View of the Rickards collection in his home in Oaxaca, circa 1910. ROM archives.

Figure 8: Plaster cast of the head of Coyolxauhqui in the ROM's Mexican gallery, gift from the Mexican Government.

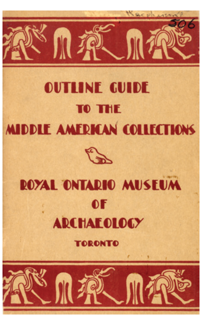
Through a compatriot working with the Mexican Light and Power Company, Currelly was able to track down the trunks in Durango and obtain passage for them to Canada, contingent on an inspection by the Mexican government. Enrique Juan Palacios, the official for archaeological monuments, was dispatched to document the contents of the trunks and authorized to withhold objects if any were deemed important to keep for the Mexican Museum. Three pieces were retained, as indicated on photographs in the ROM archives with an arrow and the word "no" (Figure 9). Mysteriously, one of the objects the government withheld did not stay in Mexico but instead ended up in the British Museum (Cat. Am 1940.02.44). According to the museum's records, C. C. James had sold it to them in 1940. James, an industrial mine supplier from Cornwell, had many business contacts in Mexico and was Constantine Rickards's best friend, but how he obtained this object from the government is not presently known and deepens the intrigue regarding the ultimate destiny of the other two objects that remained in Mexico.

When Palacios unpacked the trunks to document the collection, a number of pieces were found to be broken; without effecting repairs they were carefully repacked and shipped to Canada, arriving November 5, 1934—fifteen years after

Figure 9: Photograph taken by Enrique Juan Palacios of an object in the ex-Rickards collection retained by Mexican government. ROM archives.

the original purchase. In the catalogue that registered the newly acquisitioned objects, Currelly noted for HM 1953: “Badly damaged; extensively repaired.” Presumably he was referring to the obvious restorations visible to the naked eye, but he might also have been referring to damage that had occurred in transit.

The ROM’s reunited Mexican collection was exhibited at the museum as early as 1941. The publication *Outline Guide to the Middle American Collections* (Figure 10) illustrates how the collection, comprised mostly of ceramics and plaster casts, was displayed, and photographic records show that the urn figured prominently in the newly installed Mexican gallery for over a decade beginning in 1967 (Figure 11). Not all was well, however. Increasing knowledge of Zapotec iconography had led some scholars to question the authenticity of the urns because of incongruent combinations in costumes, adornments, and glyphs, or simply because pieces did not “feel right” (cf. Boos 1964). With the inception of thermoluminescence dating (TL) in the late 1960s (see Chapter 8), these subjective opinions were put to the test, and it became possible to show that both the suspect pieces and some that were thought to have a reasonable chance of being genuine were in fact made early in the twentieth century. Thirty-six of the ROM’s Zapotec urns were subjected to TL testing in 1977 as part of a programme organized by Philippa Shaplin, a master’s student in art history from the University of Boston, and Dr. David Zimmerman of the Center for Archaeometry at Washington University, St. Louis, Missouri.[5]



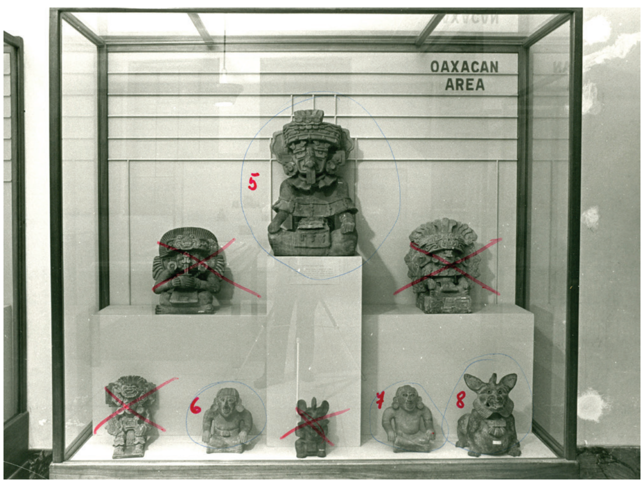


Figure 10: Guide to the ROM’s Middle American Collections, 1941.

Figure 11: View of the ROM’s Mexican gallery in 1976.

The tests showed that 32 of the 36 urns sampled were approximately 45 to 90 years old. Previous to the TL results, an iconographic study of many of the pieces by Shaplin had identified some of the specimens as probable fakes. Two specimens assumed to be of recent manufacture were shown by testing to be ancient, while one assumed to be genuine was shown to be fake (Pendergast and Farley 1986). For museums with large Zapotec collections, separating the wheat from the chafe became a new goal (cf. Goedicke et al. 1992), and Shaplin and Zimmerman's results stressed the need for more objective testing coupled with studies to better understand the aesthetic canons of the ancient Zapotec. A second line of inquiry also evolved, with the aim to comprehend the scope of the fake industry in Oaxaca and to understand the role of the collector who sold these creations to the ROM.

In 1999 the first author of this chapter assembled a team of Mexican specialists from the National Autonomous University of Mexico (Universidad Nacional Autónoma de México, UNAM) to revisit the Rickards collection, to continue TL testing of the urns and to collect a wider range of data using other analytical techniques: particle induced X-ray emission spectroscopy (PIXE), which has been extensively used to provenance ceramics, and X-ray diffraction (XRD), which is used to determine the mineralogy of clays. Our comprehensive study would also investigate the iconography of the objects and their historical context. Employing a larger sample, 86 effigy vessels in total, the UNAM team demonstrated that the collection was comprised of a substantial amount of ancient material—of the objects tested only 22 were determined to be of recent manufacture. A cluster analysis of the PIXE results established four groupings of fakes based on elemental analogies, suggesting that they were made in different workshops, or perhaps by different artisans (Sellen et al. 2003). The UNAM team did not test HM 1953 because they observed that the object had been heavily modified, and this complicated the decision of where to take the sample.

Shaplin and Zimmerman's results made it evident that Rickards had been in contact with a "fake factory" in Oaxaca. Yet, after an in-depth iconographic and historical study of the collection, another picture of his involvement emerged. The urns examined at the ROM in 1977 and 1999—80 twentieth-century creations and about 40 ancient urns—as well as similar materials in other museums, showed an unmistakable pattern: the very same specific motifs found on original works in the ROM's collection, such as a face, torso, or unique decoration, also appeared on fakes in museums all over the world. The majority of the fakes had been made by combining these copied motifs in different ways, a type of creation known as a pastiche, that is, something made up of unrelated pieces (Craddock 2009, 11). HM 1953 is also a type of pastiche, in the sense that it appears to be a genuine object that has been deceptively restored with many unrelated pieces. A pastiche has a credible appearance because its constituent parts are copied from ancient effigies; however, the motifs are assembled in ways that violate the ancient Zapotec canons of composition. A specific motif that decorates only the headdress on original urns, for example,

may be used as a pendant on a fake urn. In a pastiche urn, the visual vocabulary is fine, but the words are arranged according to a different, and meaningless, grammar. By mixing and matching a wide variety of moulded motifs to create each urn, forgers could make an unlimited number of urns in as many different combinations as they liked. For example, a representation of corn held in the right hand of an ancient urn from the Rickards collection (HM 1399) shows that this detail was once broken off, facilitating the fabrication of a mould, and then carefully glued back on. The corn feature appears in a litany of other fake, pastiche urns from collections in museums around the globe (Figure 12). What is interesting about this detail is that it is unique to this particular style of ancient urn and has not appeared on any other artefact from the epoch.

Identifying impressions taken from ancient fragments and then applied to fake, pastiche urns tell us a lot, not only about the methods of the forgers but also about which objects came from their workshops. Knowledge of this technique helped us locate another urn that comes from the same locale as HM 1953. An impression taken from the ancient bird-wing fragment glued to the top of HM 1953's headdress, and used to create the three decorative glyphs on the loincloth, also appears on an urn we discovered in the collections of the British Museum. In this case the bird-wing glyph is attached to the front of headdress (Figure 13). This urn has been submitted to a TL test and was determined to be a twentieth-century creation (Craddock 1991, 141). It was one of many fakes donated to the British Museum in 1908 by Sir Reginald Tower, who was

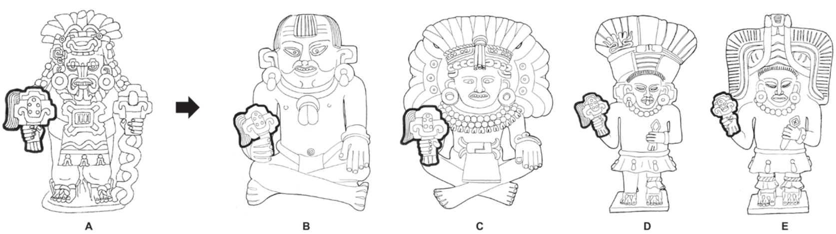


Figure 12 : **a.** Royal Ontario Museum, Toronto; **b.** Museum für Völkerkunde, Berlin; **c.** Ethnographic Museum, Stockholm; **d-e.** University of Pennsylvania Museum, Philadelphia.

Figure 13: Fake effigy vessel in the British Museum, Cat. no. AM 1908,07187. (Drawing by author).

diplomatic envoy to Mexico between 1906 and 1910, at around the same time that Rickards acquired HM 1953. Tower and Rickards were both diplomats and undoubtedly knew each other, but more importantly, the donation of the British Museum urn was facilitated by the renowned Mayanist Alfred Maudslay, a personal friend of Rickards who had invested in a gold mining operation in the state of Oaxaca. What we can deduce from this story is that the person (or persons) who possessed the originals from which these moulds were taken was very likely involved in producing the fakes.

In other publications, the first author (Sellen 2004, 2008) has suggested that Rickards and his intriguing life made him a prime suspect for forgery. His increasingly dire financial situation was a strong motive to sell fakes to unsuspecting buyers. Furthermore, he had published images of fake urns in his 1938 monograph on Zapotec iconography, including one example that is a copy of an ancient urn that he once owned. This detail surely condemns the former British vice-consul. The image of evil genius spitefully working away in a dimly lit basement may not apply, however; Rickards could have employed local craftspeople, versed in an enduring ceramic tradition, to furnish him with the wares. He may have provided the potters with his originals for the fabrication of moulds and perhaps played a key role in orchestrating the iconographic details they should bear. His visual knowledge, combined with the skill of native potters who are the heirs to a pre-Hispanic ceramic tradition, would have resulted in credible creations. Considering also Rickards's social standing and credentials, it is easy to see how even the greatest experts, such as Eduard Seler of the Museum für Völkerkunde in Germany, were fooled by these faux urns. Did Rickards organize a group of talented artisans near the city of Oaxaca to elaborate these creations based on the originals in his collection, or did he just buy spurious wares from different potters and then try to sell them to unsuspecting scholars? Was he the mastermind behind this massive faking industry or just one of many? We may never know the extent of his involvement or how exactly this industry was organized, but again, HM 1953 has offered some clues regarding the location and timing of the fake workshops.

The study of materials from older archaeological collections can help to recuperate provennce and contextual data for artefacts that over time have been divorced from this vital information. References to pre-Hispanic artefacts in nineteenth-century collections notes, drawings and photographs, combined with a diversity of other documentary sources in museum archives, are links to the biography of objects that have often languished for decades in museum storerooms before being seriously examined.

Archives and archaeological contexts, however, can only tell part of the story. HM 1953, an oddity among ancient and spurious urns, provides us with a perfect opportunity to use the ROM's considerable analytical tools to trace its particular history and understand how the various strands of pre-Columbian fakes merge museum collections all over the world. The material analysis of HM 1953 takes up the second part of this book.

Endnotes

1 Rickards to the Director of Bellas Artes, 12 September 1916, Archivo General de la Nación, Instrucción Pública y Bellas Artes., box 158, file 33, pp. 1–2; Rickards to the Director of Bellas Artes, 7 November 1916, AGN/IPBA, box 158, file 33, p. 28.

2 Manuel Gamio to C. T. Currelly, 14 April 1919. ROM Archives.

3 C. T. Currelly to Vincent Massey, 14 November 1927. ROM Archives.

4 James E. Kitchin to C. T. Currelly, 9 January 1930. ROM Archives.

5 Shaplin and Zimmerman also tested urns at the Peabody Museum at Harvard University, and the Morton D. May Collection at the Saint Louis Art Museum. See Shaplin and Zimmerman, 1978.

References Cited

Boone Hill, Elizabeth, ed. 1993. *Collecting the Pre-Columbian Past.* Washington, DC: Dumbarton Oaks.

Boos, Frank H. 1964. Vol. 1. *Las urnas zapotecas en el Museo Real de Ontario. Corpus Antiquitatum Americanensium.* Mexico: Instituto Nacional de Antropología e Historia y Unión Académique Internationale.

——— 1966. Vol. 2. *Las urnas zapotecas en el Museo Frissell. Corpus Antiquitatum Americanensium.* Mexico: Instituto Nacional de Antropología e Historia y Unión Académique Internationale.

——— 1968. Vol. 3. *Colecciones Leigh, Museo Frissell de Arte Zapoteca, Smithsonian Institution, y otras. Corpus Antiquitatum Americanensium.* Mexico: Instituto Nacional de Antropología e Historia y Unión Académique Internationale.

——— 1966. *The Ceramic Sculptures of Ancient Oaxaca.* New York: A. S. Barnes.

Brownstone, Arni, ed. 2015. *The Lienzo of Tlapiltepec: A Painted History form the Northern Mixteca*. Norman: University of Oklahoma Press.

Chassen, Francis R. 1990. "El *boom* Minero porfirista." In *Lecturas históricas del estado de Oaxaca, vol. IV, 1877-1930*, edited by Ma. de los Ángeles Romero Frizzi, 73–106. Colección Regiones de México, Instituto Nacional de Antropología e Historia, Gobierno del Estado de Oaxaca.

Craddock, Paul. T. 2009. *Scientific Investigation of Copies, Fakes and Forgeries*. Oxford: Elsevier.

Craddock, Paul T., and Bowman S. 1991. "Spotting the Fakes." In *Science and the Past*, edited by P. Bowman, 141–57. British Museum Publications.

Ekholm, Gordon F. 1964. "The Problem of Fakes in Pre-Columbian Art." *Curator* 7, no. 1: 19–32.

Goedicke, Christian, Sabine Henschel, and Ursel Wagner. 1992. "Thermolumineszenzdatierung und Neutronenaktivierungsanalyse von urnengefassen aus Oaxaca." *Baessler-Archiv* 40: 65–86.

Kelker, Nancy L., and Karen O. Bruhns. 2009. *Faking Ancient Mesoamerica*. California: Left Coast Press.

König, Viola. 2003. "Eduard Seler y Caecilie Seler-Sachs en Oaxaca." In *Eduard y Caecilie Seler: Sistematización de los estudios americanistas y sus repercusiones*, edited by Renata von Hanffstengal and Cecilia Tercero Vasconcelos, 325–36. Mexico: CONACULTA-INAH.

König, Viola, and Adam Sellen. 2015. "Using Nineteenth-Century Data in Contemporary Archaeological Studies: The View from Oaxaca and Germany." In *Bridging the Gaps. Integrating Archaeology and History in Oaxaca, Mexico. A volume in Memory of Bruce E. Byland*, edited by Danny Zborover and Peter Kroefges, 391–410. Boulder: University of Colorado Press.

Maclaren Walsh, Jane. 2005. "What is Real? A New Look at PreColumbian Mesoamerican Collections." *Anthronotes* 26, no. 1: 1-7, 17-19.

Mongne, Pascual. 1987. "Les Urnes Funéraires Zapoteques: Collectionnisme et Contrefacon." *Journal de la Société des Américanistes* 73: 7–49.

——— 2000. "Le faux zapotèque et la collection Gustave Bellon: Iconographie, thermoluminescence et nouvelles considerations." *Techne* 11: 53–64.

Parmenter, Ross. 1961. *20th Century Adventures of a 16th Century Sheet: The Literature on the Mixtec Lienzo in the Royal Ontario Museum*. Boletín de Estudios Oaxaqueños, no. 20. Museo Frissell, Mitla.

Pendergast, David, and Catherine Farley. 1986. “The Good, The Bad and The Collector,” *Rotunda* 19 (2): 11.

Rickards, Constantine George. 1910. *The Ruins of Mexico*. London: H. E. Shrimpton.

——— 1913. “Notes on the ‘Codex Rickards.’” *Journal de la Societé des Americanistes*, Nouvelle Serie, vol. X: 47–57. Paris.

——— 1922. “Ligero estudio sobre unos tubos de barro con jeroglíficos encontrados en el estado de Oaxaca.” *Anales del Museo Nacional de México*, Época IV, No. 1: 49–52.

——— 1938. “Monograph on Ornaments on Zapotec Funerary Urns.” *Journal de la Societe des Americanistes*. Nuovelle Serie. Tomo 30 (1): 147–65. París.

Saville, Marshall. 1899. “Exploration of Zapotecan Tombs in Southern Oaxaca.” *American Anthropologist* 1: 351–62.

——— 1904. “Funeral Urns from Oaxaca.” *The American Museum Journal* 4: 51–60.

Schávelzon, Daniel. 2009. *Arte y falsificación en América Latina*. Buenos Aires: Fondo de Cultura Económica.

Sellen, Adam. 2000. “Breve historia sobre la colección Rickards en el Museo Real de Ontario.” *Estudios Mesoamericanos* No. 1: 14–23.

——— 2004. “Is this the Face that Launched a Thousand Fakes?” *Rotunda* 36 (3): 32–39.

——— 2008. “El Cónsul del engaño ¿Rickards el falsificador?” In *Estas ruinas que ves*, edited by Mariana Castillo Deball, 81–89. Mexico: Sternberg Press.

——— 2015a. *The Orphans of the Muse. Archaeological Collecting in Nineteenth-Century Oaxaca*. Merida: Centro Peninsular en Humanidades y Ciencias Sociales.

——— 2015b. Zapotec Effigy Vessels. Database in English and Spanish, Los Angeles County Museum. http://ancientamericas.org/collection/browse/492

Sellen, Adam, Yolanda Martínez, José Luis Ruvalcaba-Sil, Ángel Ramírez, and Lauro Bucio. 2003. “Analysis of Zapotec Urns from the Royal Ontario Museum,” abstract *en extenso* (5 pages), *The Use of Ion Beams in Materials Sciences, Medicine and Archaeometry*, Namur, Belgium, May 22–24, 2003.

Shao, Paul. 1976. *Asiatic Influences in Pre-Columbian American Art*. Ames: The Iowa State University Press.

Shaplin, Philippa D., and David Zimmerman. 1978. “Thermoluminescence and Style in the Authentication of Ceramic Sculpture from Oaxaca, Mexico.” *Archaeometry* 20 (1): 47–54.

Van Doesburg, Sebastian. 1998. “Commercializing Coixtlahuaca History: the Twentieth-Century Adventures of the Lienzo de Tlapiltepec.” *Mexican Codices and Archeology, Indiana Journal of Hispanic Literatures* 13: 7–16.

PART II

The conservator seeks to understand the artefact from a material point of view: What is its condition? How was it made? Equally important is the appreciation of its artistry, context, meaning, and significance. These may substantially affect different aspects of the object's preservation.

LAURA LIPCSEI

CHAPTER 5

Visual Examination and Material Analysis

LAURA LIPCSEI / ROYAL ONTARIO MUSEUM

Urn HM 1953 was brought to the Conservation Laboratory at the Royal Ontario Museum to better understand its complex history. We had been particularly interested in the similarities between our urn and two other urns now in collections in Berlin and Mexico (see Chapter 13). The three objects are nearly identical, with one major difference, the treatment of the nose, as seen in figure 1. The Zapotec often made a series of companion urns (see Chapters 2 and 3), but evaluating the object would require us to go back in time through what appeared to be multiple repairs and additions to an ancient core.

As shown in previous chapters, our questions about HM 1953's story led us to consider more fully the urn's original use and its circuitous journey to the museum in the early twentieth century. Further understanding of the urn's history could be achieved through an in-depth examination of the urn itself. When any object comes into the Conservation Laboratory, the first step in a physical investigation for condition assessment, stabilization, or study is to conduct a complete visual examination of the artefact. The conservator seeks to understand the artefact from a material point of view: What is its condition? How was it made? Equally important is the appreciation of its artistry, context, meaning, and significance. These may substantially affect different aspects of the object's preservation.

Although the conservator's goal is always to be least invasive, in some cases a small sample must be taken in order to analyse the material using a specific scientific method—to obtain information that cannot be obtained any other way. Where a sample is to be removed, efforts are made to take a bare minimum—only what is necessary and justified to obtain the desired results. This chapter discusses our comprehensive visual examination of the urn under different light sources (normal and ultraviolet) and magnifications.

ROM, Toronto, HM 1953

Ethnologishes Museum, Berlin, IV Ca 2836

INAH, Oaxaca, MFR 1224

Figure 1: HM 1953 with possible companion urns.

In subsequent chapters, our investigation expands to incorporate different imaging techniques to look not only at the surface of the object (normal photography), but also its internal structures (X-ray and computed tomography (CT) imaging).

Many of our questions were answered through our visual examination, but some questions required additional analysis; we needed to look at the urn on a molecular level. A subsequent chapter discuss X-ray fluorescence spectrometry (XRF), a non-destructive technique that we used to gather information about the chemical composition of our ceramic urn. The XRF results were paired with data on mineral composition that were obtained by taking thin-sections of the urn for petrographic analysis. Visual examination identified the pieces brought together to make HM 1953. XRF and thin-section petrography can determine if these pieces were made using distinct clay sources.

Thermoluminescence (TL) is a technique that uses a small sample to date ceramic materials. In this case, we used thermoluminescence to determine the relative age of HM 1953's parts vis-à-vis each other. The last analyses done on the urn—vibrational and optical microscopy—were used to chemically identify materials, from the pigments used to decorate HM 1953 to the various substances used to repair the urn throughout its lifetime. Because we can determine when certain materials were introduced, we can establish a timeline for when the urn was created and when it was repaired or restored.

Condition

Urn HM 1953 appears physically stable overall (Figure 2). We note major losses at the tongue, front of the collar at the neck, and at the figure's right ear; there is also delamination, or skinning of the surface, at the nose. There are scratches,

Figure 2: HM1953 with 'day glyph' and flange.

Figure 3a: Traces or root action on urn HM1953.

Figure 3b: Root accretions across surface of MFR1224.

chips, worn surfaces, and minor losses throughout, all consistent with an object of some age (the urn is dated to circa 300 CE) and which has been excavated archaeologically. A crack in the ceramic cylinder extends 13 cm down from the rim; although it is considerable, it does not pose a threat to the vessel's stability. There is what appears to be powder on the ceramic surface. This is common to archaeological ceramics and could be a thin layer of soil from burial or possibly the powdering of the ceramic surface due to damage caused by the presence of salts introduced during burial. Squiggly line impressions provide some evidence for root action that suggests that the urn had come from a burial context (Figure 3a). Root accretions are nowhere near as abundant as those found elsewhere—for example, on an urn in a collection in Mexico, MFR 1224 (Figure 3b). This simply shows that the level of deposition and preservation of such material on objects found in different burial contexts varies greatly. It also suggests that our urn was quite likely scrubbed clean at some point in its life, following excavation. Insect carcasses and webbing deposited during post-excavation storage were found inside crevices. Straw and paper packing materials were discovered inside the cylinder and lodged in recesses.

Visual Examination

Even a cursory visual examination makes it is immediately apparent that urn HM 1953 has been reconstructed from several fragments. Adhesive residues, flaking, and discoloured restoration materials used to fill losses and conceal join lines and repairs are quickly apparent to the trained eye (Figure 4). Deteriorating restoration materials are found at the sides of the nose, proper left ear spool, and shoulders (Figure 5a–c), hip joints (Figure 6a and b), flanges (Figure 7a and b), and the headdress. Note, too, the mottled surface and uneven colouration across the surface of the vessel: for example, the shoulder sections are darker than the body to which they are attached, and the figure's proper left arm is darker than its proper right arm.

Figure 4: Join lines and the associated fragments from HM 1953.

Figure 5a: Flaking restoration materials.

Figure 5b: Cracking restoration of proper left ear and earspool.

Figure 5c: Detail of cracking restoration over proper left earspool.

Figure 6a: Proper left back ¾ view.

Figure 6b: Proper right back ¾ view.

Figure 7a: Cracking restoration on the proper left flange.

Figure 7b: Cracking restoration on the back of the proper left flange.

Two fragments are now detached from the vessel: the first (Figure 8a) had been adhered to the spot on the headdress usually reserved for a day glyph (Figure 8b), and the second is a headdress flange (Figure 9). These appear to have formerly been attached to the urn using an adhesive, putty, and fill materials that still remain on their surfaces. These fragments are stored with the object and are accessioned as parts of the urn.

Immediately problematic is the fragment from the headdress, in figure 8a. According to Sellen, this fragment is not a day glyph at all but rather the representation of a bird's wing (see Chapter 3). The motif is nonsensical and has no meaning in the urn's context. Sellen suggests that this fragment was taken from another object altogether and incorporated into HM 1953 by someone with little to no knowledge of the ancient culture and glyphs.

Figure 8a: Detached fragment of bird's wing motif added to headdress.

Figure 8b: Brown putty used to attach fragment to headdress.

Figure 9: Headdress flange.

In addition, it appears that the bird's wing fragment was used to create a mould from which three more plaques were made. These were applied to the loincloth of the figure (Figure 10a–b). All three cast elements have an identically situated crack and other unintended details that exist in the original fragment. As well, the three copies are each approximately a third smaller in volume due

to shrinkage from subsequent firing of the ceramic material in a kiln (Figure 10c). When pushed into the mould, the ceramic material was the same size as the original fragment; however, loss of water in the clay caused the replicas to shrink significantly during the firing process. Furthermore, the repeated use of a decorative element on the figure's loincloth is unprecedented in any Zapotec urn to date, although it does appear in the headdress of another fake urn (see Chapter 4, Figure 13).

Figure 10a: Row of lap plaques.

Figure 10b: Lap plaques side view.

Figure 10c: Comparing plaque sizes: Lap plaques are proportionately smaller than the bird's wing motif from which a mould was taken. Subsequent firing results in shrinkage of the final product.

Construction, Manufacture and Technology

Urn HM 1953 stands 56 cm high, 41 cm deep, and 38 cm wide. The effigy and cylinder of the urn is made from a low-fired earthenware, likely fired in an open pit or pyre kiln up to 1100°C. The object, however, appears to have been fired unevenly and is probably composed of fragments from different vessels—some parts of the urn are a light orange buff to light grey colour while others are black, reflecting different compositions, firing temperatures, and degrees of oxidation. The proper left arm, for example, is black, whereas the proper right forearm is a lighter orange-brown. The figure's shoulders are darker than its torso.

Shaplin (1975) describes the steps involved in making similar urns (Figure 11). The process started with building a central cylinder, either from a slab of a flattened sheet of clay or from coils looped on top of themselves and smoothed to a flat surface. Then, through an additive process, smaller decorative elements, either hand built or press moulded, were attached to the cylinder. These would be leather-hard and luted to the cylinder: joining surfaces would first be abraded and then a slip and additional small bits of soft clay would be used to join the abutting elements. Various techniques were then used to create additional features, including hand modelling and carving, followed by engraving and incising. Finally, the whole assemblage was fired in a pit or primitive kiln.

Slab- and coil-built constructions can be distinguished using xeroradiography. Coil-built constructions exhibit telltale signs: the directional orientation of temper in the ceramic matrix as well as air pockets and voids between rows of laid coils (Figure 12). Where xeroradiography is not available, raking light can be used to look for features in the surface that might provide clues. Looking at our urn under raking light, one can see that the surface has regular undulating swells that indicate row upon row of stacked coils up the height of the urn (Figure 13a and b). Also evident is that the surface was smoothed vertically with a tool.

It appears that the figure's forearms have been fashioned from smaller cylinders made out of slabs of clay, which were then cut in half (Figures 14a–c). The arms are unusual: examples from related urns exhibit arms that are three-dimensional and more volumetric, in other words, more realistic and less schematic in form. Sellen has, however, uncovered another example of this exceedingly rare type of arm in the collection of the National Museum of Anthropology in Mexico City (Figure 15, Accession no. 6-6592). However, when comparing the two arms on the ROM vessel, the left arm is substantially thicker than the right, and may have been made in a different campaign.

Fingerprints in bits of clay at the intersection of joined elements are evidence of the handbuilding process. These are found, for example, at the back of the ears, on the interior of the face and headdress, and under the neck collar (Figures 16–18). Fingerprints on the inside of the face and headdress also show the working of the clay during assembly.

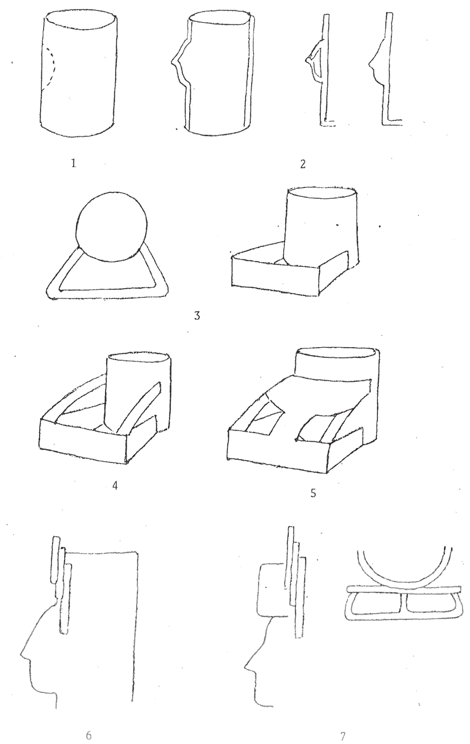


Figure 11: Shaplin's schematic of steps in urn construction.

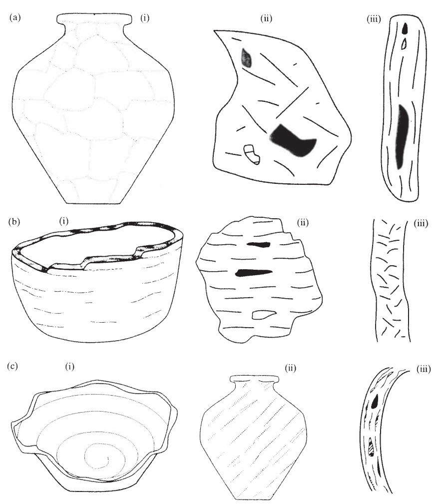


Figure 12: Xeroradiography schematic showing different construction techniques of a) slab, b) coil, and c) wheel-made vessels.

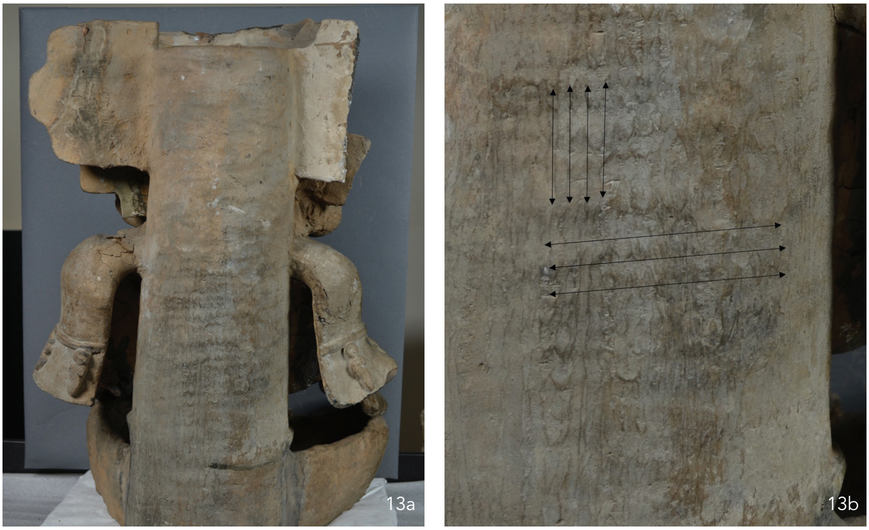


Figure 13a–b: Vertical and horizontal features on cylinder that suggest coil construction.

Figure 14a: Arms, front view.

Figure 14b: Arms, side view from proper left.

Figure 14c: Arms side view from proper right.

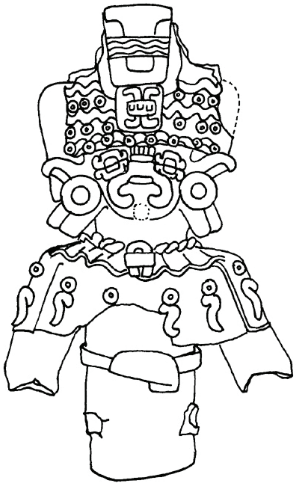


Figure 15: Half round arms on urn in Mexico MNA 6-6592.

Figure 16–18: Examples of the addition of clay pressed into the corners to secure joins from the proper right ear, headdress, and under the collar.

The ROM vessel incorporates hand-built elements including bean shapes, round beads, and wavy lines, etc. (Figures 19 and 20), which were then luted to the surface. Mould-made elements in HM 1953 are the ear spools (Figure 21a). There is an example of an ear spool stamp in the ROM's collection (917.4.137, Figure 21b). Other, more elaborate urns, show more extensive use of moulds; for example, urn 30/6335 in the collection of the American Museum of Natural History, which shows their use in repetitive motifs such as maize cobs (Figure 22a and b). Telltale signs of the use of moulds are motifs with soft edges and reduced definition, as shown in Figure 23, where the mould slipped a little while pressing the soft clay, creating a "lip" or tapered edge which then hardened in the kiln fire.

There are several areas on HM 1953 that demonstrate the use of tools. One example is of using tools to create incised lines for added definition. There are sharply defined lines and details on the figure's hands, tongue, mouth, and eyes (Figure 24 and 25). A tiny wafer created by the cutting of the surface at the corner of mouth was preserved in the firing (Figure 26). Cylinders with sharp ends were used to cut decorative elements into the headdress, eyelashes, and ear spools (Figures 27–29). Quite interesting are the unintended marks made by these cylinders when they were inadvertently pressed into the front of the figure's legs, leaving circular impressions similar in diameter to those used on the headdress elements (Figure 30a–d).

Covering the entire surface of the urn is a very thin wash of a light- to medium-grey-coloured slurry, composed of a silt clay or mud. This appears to have been applied to visually unite all of the differently coloured ceramic bits and pieces. While it was obviously applied in an attempt to hide restoration work, perhaps it also served to give the impression that the urn had been freshly excavated. Holmes, writing in 1886, describes the process used by forgers of the time attempting to convert new creations into ancient pieces from burial contexts:

> After finishing, the vases are prepared for market by burial for a short time in the moist earth, or, more frequently perhaps, by simply washing them with a thin solution of clay. The deposit of clay is afterwards partially wiped off, leaving the lines and depressions filled with the light coloured deposit. So clever are these fellows that the vessels are sometimes slightly mutilated before they are submitted to this finishing process (171).

The grey clay-like wash (Figures 31a–c) was not applied in an even or consistent manner over the surface of the vessel (Figure 31c). This gives the urn an overall mottled appearance. There are several areas that were left bare, revealing the underlying buff-coloured ceramic (Figure 31d). Spot tests indicate that this thin grey layer is water-soluble. Discrete areas were cleaned using cotton swabs moistened with deionized water to expose the ceramic

below (Figure 32). Break edges of sherds were similarly cleaned to allow for examination of the pottery throughout its matrix.

A loose and powdery orange soil was also present across the surface; again, this was presumably applied to give the urn a soiled appearance, while simultaneously creating a homogenous surface to unite the disparate parts of the urn.

Visual examination showed that more than one type of ceramic was used in the construction of the urn. On one hand, there is a smooth, light apricot- and buff-coloured ceramic with a fine matrix and fine inclusions (Figure 33a and b). This appears to have been unevenly fired, and a light-grey core can be observed on some of the break edges of the sherds (Figure 34) or alternately where their surfaces have been burnished or worn, leaving a light grey/taupe colour (Figure 35). There is a second, coarser black ceramic fabric with large white inclusions (Figure 36a–c) that appears to have been misfired in some sherds since it ranges in colour from orange/red to grey/black, within the same fragment (Figure 36d).

In summary, it appears as though there were two campaigns in the creation of this urn. The first produced the central core, constructed from fine, light-buff-coloured earthenware. This is believed to have been the remnant of the original vessel. The newer additions, made of a coarse black pottery, appear to have been added to replace originals that had fallen off and are now lost.

Figure 19: Example of applied decoration, rain drop.

Figure 20: Example of applied elements and cylinder cuts.


21a


21b


22a


22b


23


24


25


26

Figure 21a: Proper right earspool, centre cylinder cut.

Figure 21b: Earspool stamp ROM 917.4.137.

Figure 22a: Example of an urn from the AMNH accession no. 30 6335.

Figure 22b: Detail of maize motif on AMNH accession no. 30 6335.

Figure 23: Evidence for use of mould, tapered edges and excess 'lipping'.

Figure 23: Evidence for use of mould, tapered edges and excess 'lipping.'

Figure 24: Incised hands.

Figure 25: Incised tongue.

Figure 26: Cut mouth, detail.

Figure 27: Cylinder cuts.

Figure 28: Cylinder cuts.

Figure 29: Eye detail, incision and cylinder cuts.

30a


30b

30c


30d


31a


31b


31c


31d

Figure 30a: Cylinder cuts on earspool.

Figure 30b: Accidental circular impression made by cylinder.

Figure 30c: Circular impression measures approximately 7 mm.

Figure 30d: Accidental semi-circular impression made by cylinder.

Figure 31a: Grey clay like wash, or skim coat.

Figure 31b: Grey clay like wash, or skim coat.

Figure 31c: Mottled surface, grey wash.

Figure 31d: Detail of spotty coverage of grey wash reveals buff coloured ceramic underneath.

Figure 32: Grey wash is water soluble.

Figure 33a: Buff coloured ceramic.

Figure 33b: Buff colour under 10 x magnification.

Figure 34: Grey core, unevenly fired, observed at break.

Figure 35a: Grey in areas.

Figure 35b: Grey in areas.

Figure 35c: Burnished grey surface shines on back of cylinder.

Figure 36a: Black proper left arm.

Figure 36b: Black arm detail.

Figure 36c: Black shoulder revealed under clay skim coat.

Figure 36d: Unevenly fired ceramic.

Polychromy and Pigment Traces

A close look at the ROM urn reveals traces of red pigment over the surface. As seen in Figures 37a–e, five spots were identified: on the headdress between the interstices of the beans; 2) on the front of the headdress; 3) on the proper right side of the headdress; 4) below the loin cloth between the knees; 5) on the proper left ear spool. There is at least one example of yellow pigment found on the cylinder, next to the point where the figure's right leg was attached (Figure 38). The pigment identified seems to be concentrated along the central axis/core of our piece. Wetting the surface makes the pigment more apparent (see Figure 37f) as it becomes more saturated and vibrant in colour, in some instances even under the thin layer of grey silt and soil.

Preservation of the pigment is poor. It is powdery and friable, and as a result, very little of it remains except in areas protected from rubbing and handling, such as the interstices of the ceramic body and the areas in and around raised elements. Historically, the loss of the original polychromy on archaeological ceramics from a burial context is to be expected. Soils wear and abrade surfaces, and ground water washes pigments away. During and after excavation, more pigment may be lost as objects are handled while they are being unearthed, by dealers and buyers, and by those packing them for transport to final destinations in private and museum collections.

Close examination of the red pigment shows that it was thinly applied directly onto the ceramic with no apparent ground layer or surface preparation. There is, however, one exception: there is an unusual surface treatment on the lower part of the cylinder, between the legs. This areas looks as though it has been given a preparatory ground layer which appears to be plaster. On top of this is a layer ranging in colour from dark grey/black to dark green (Figure 39a–b). The presence of this material raises questions. Could this have once been a different colour that has since altered and now appears as we see it? Is it composed of an iron oxide or hematite red pigment that has now oxidized to black? Why does this area have a different pigment than that found elsewhere on the urn? Is this original or does it represent remnants of a later restoration?

Samantha Alderson, Conservator, American Museum of Natural History, has published one of the few technical papers on this subject. Her article focuses on pigments found on Zapotec urns and related material from the tombs at Xoxocotlán. Her study includes the analyses of more than 100 pigment samples using microchemical tests, polarizing light microscopy, and SEM-EDS (Alderson, 2002). She summarizes her findings in a chart, listing the six colours she identified in her research: white composed of calcium carbonate; black made of carbon; yellow or Goethite which is an iron oxide; Maya blue, a pigment specific to Latin America; and two reds, hematite (also an iron oxide) and cinnabar (mercuric sulphide).

Alderson also cites examples where several layers of colour had been applied to one vessel, with a white ground layer applied in between applications of red

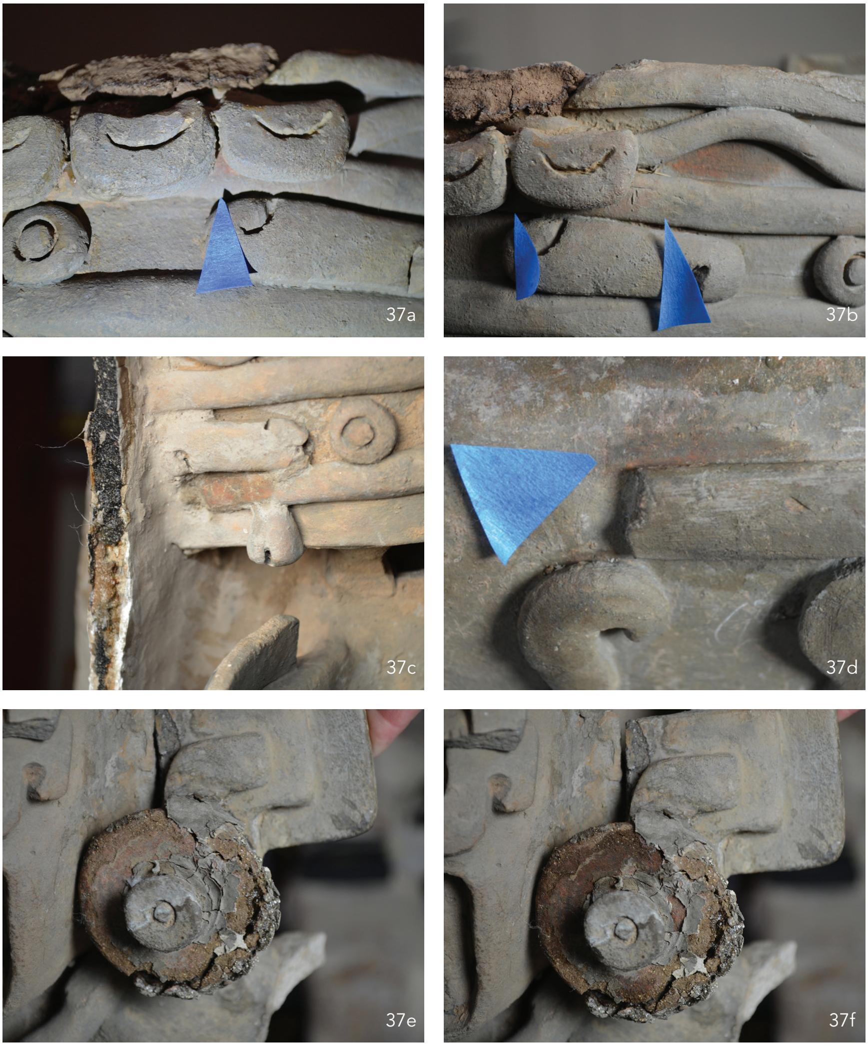


Figure 37a: Red pigment found in interstices of coefficients on headdress.

Figure 37b: Pigment found on headdress at front.

Figure 37c: Pigment found on the proper right side of headdress.

Figure 37d: Pigment found at front between legs below loincloth.

Figure 37e: Pigment found on earspool.

Figure 37f: Proper left earspool saturated with water shows vibrant colour.

Figure 38: Yellow pigment, proper right side of cylinder near leg join.

Figure 39a: White ground layer, and discoloured overpaint.

Figure 39b: White ground layer with discoloured overpaint.

paint. Perhaps this is what happened with our urn—we too find a white ground layer preserved on the cylinder in the area between the legs. A tiny trace of sulphur was identified, possibly indicating a layer of stucco or plaster (calcium sulphate) as the intermediary layer applied to the surface before the paint.

Alderson has further found examples of excavated urns that have been repainted at some point in their past. She hypothesizes that the urns had been redecorated and then reused after being broken or even after being excavated from a previous burial in pre-Hispanic times. She cites an example where pigment was found on the break edge of a sherd of ceramic—and therefore clearly applied after the object had been broken in order for it to be refreshed and used once again.

Ultraviolet Induced Visible Fluorescence[1]

Another useful technique in the visual examination of artefacts is the use of long-wave ultraviolet radiation, known as UVA, which is composed of wavelengths of light between 320 and 400 nanometres. Conservators subject artefacts to large doses of UVA with a specialized lamp that is restricted to wavelengths in the UVA

range in an otherwise dark room to prevent interference from other wavelengths of light. The various materials that make up an object absorb UVA differently and emit different wavelengths of radiation that may be visible to the human eye. The visual disparities in the colours given off, also known as fluorescence, help in distinguishing the presence of dissimilar materials.

In museums, UVA is commonly used to detect foreign or newly added substances to an object. Restorers hide their work by expertly camouflaging added materials to look like the original, surrounding areas on an object, thus rendering repairs invisible in normal light. These may become apparent, however, when viewed in different wavelengths of light, UVA in particular.

In figures 40 and 41, urn HM 1953 can be seen in normal light and ultraviolet light. When looking at the fluorescence emitted by the different materials making up the urn, the eye is immediately drawn to the brighter areas. The brightness indicates the presence of adhesives, consolidates, binders, and other restoration materials. Note the fluorescence of materials used to attach, coat, and consolidate the nose, ear and ear spool, ear spool knobs, cape shoulders, proper left forearm, loincloth plaques, and headdress flanges. Note the adhesive used to attach the false day glyph to the spot on the headdress, the front repair of the legs, proper left hand, and proper right knee. Note the yellow fluorescence on the side and bottom views, and the drip marks of adhesive throughout.

The materials that do not fluoresce include the original ceramic body (most of the urn, along the central axis); the brown putty, seen at the hip and leg joins on the underside of the loincloth; the headdress; and an adhesive found in several areas.

Conclusion

The visual examination of urn MH 1953 reveals that it is, at its core, an object of some age, likely made in antiquity with construction techniques of the period and similar to other contemporaneous urns. The investigation further indicates that the vessel was restored in several campaigns with materials that are different from the original, as seen both in normal and in ultraviolet light.

As will be seen in the following chapters, the information gathered about the urn through a thorough visual examination was corroborated by the data obtained using other non-destructive instrumental techniques such as X-ray fluorescence spectroscopy, X-radiography, and computed tomography, revealing anomalies in its construction and raising questions about its history and authenticity that were worthy of further exploration and ultimately destructive analysis.

Endnotes

1 To learn more, see *Conserve O Gram* on Ultraviolet Induced Visible Fluorescence, Part I and II by Martha Simpson Grant, December 2000: https://www.nps.gov/museum/publications/conserveogram/01-09.pdf and https://www.nps.gov/museum/publications/conserveogram/01-10.pdf

Figure 40: HM 1953 front view under normal and ultraviolet radiation.

Figure 41: HM 1953 side and bottom views under normal and ultraviolet radiation.

References Cited

Alderson, Samantha. 2002. "A Technological Study of the Painted Surfaces of Zapotec Urns from Xoxocotlán." In *AIC Objects Specialty Group Postprints*, Vol. 9, compiled by Virginia Greene and Patricia Griffin, 146–60. The American Institute for Conservation of Historic and Artistic Works.

Lang, J. and Andrew Middleton, (eds.) 1997. *Radiography of Cultural Material*. Oxford: Butterworth-Heinemann.

Holmes, William H. 1886. "The Trade in Spurious Mexican Antiquities." *Science* 7 (159): 170–72.

Shaplin, Philippa D. 1975. "An Introduction to the Stylistic Study of Oaxacan Urns." Unpublished masters thesis on file at Wellesley College Department of Art, Boston.

CHAPTER 6

X-radiography

SUSAN STOCK / ROYAL ONTARIO MUSEUM

As discussed in the preceding chapter, every artefact study begins with a thorough visual examination of the object. This may involve using several basic optical techniques, including general visual examination and stereomicroscopy, as well as a variety of more-advanced optical lighting techniques, such as ultraviolet (UV) or infrared (IR) imaging. Usually, these techniques are sufficient to identify and answer questions concerning condition, previous treatments, repairs, stability, fabrication, inherent vice, and even provenance. However, when careful surface examination exposes anomalies or inconsistencies in style, materials, or method of manufacture, further investigation and analysis may be necessary to clarify the situation.

Difficulty arises when an artefact is intact, or appears to be so on first viewing. At the very least, one cannot see with one's eyes what lies beneath without destructive removal of surface overfilling. Our preliminary X-ray of urn HM 1953 prompted a thorough visual analysis, and we agreed that further X-raying, which would not require altering or removing any surface material, was a necessary first step toward determining what had happened to the urn; we could visually dismantle it without actually dismantling it.

X-radiography can be used to see beneath the surface of an object, revealing significant structural information including interior structures, manufacturing techniques (Berg, 2008), thickness, breaks and joins, voids, losses, repairs, and alterations. A non-invasive and non-destructive technique, X-radiography provides us with data that help us decide if we should pursue a more active investigation. In most cases, conservators and curators avoid invasive intervention, including the removal of samples for destructive testing, unless the situation absolutely warrants it. Hence the strong appreciation for non-destructive testing techniques, especially during preliminary investigation. Radiography can be useful prior to physical sampling to provide details about the structural components of an artefact, guiding conservators toward the ideal locations for sampling.

Since different materials conduct X-rays differentially, and since thickness affects the ease with which X-rays pass through an object, variations in a

material are made visible in the shades of black, grey, and white on an X-ray plate. The darkest areas on the plate are those that have been exposed to the X-rays—in other words, the X-rays passed through the material easily. The white areas reflect radio-opaque areas that did not allow the X-rays to pass through and expose the plate. The grey areas represent materials with varying abilities to transmit X-rays to the imaging plate. One can often tell the difference in the composition of an object by looking at and comparing inclusions or lack thereof; differences in porosity; and differences in thickness across an object, as most show a consistency of material across the piece. The careful reading of an X-ray aids in choosing sample sites that best target the research question while limiting the sampling's impact on the integrity of the object.

The only complication in using X-radiography on ceramics or objects with ceramic cores is that it may corrupt data relating to absolute dating using the thermoluminescence (TL) technique (Craddock 2009, 32; Lang and Middleton 1997, 62). As discussed in Chapter 8, exposure to X-rays excites the electrons within the ceramic matrix, rendering inaccurate the determination of absolute dates for when the object was fired. Nonetheless, new techniques are being developed to calculate X-ray exposure and compensate in the TL calculations for any alteration caused by X-ray exposure (Bortolot 2016; also see Chapter 8).

To continue our investigation, the X-ray suite was booked for October 24, 2014. The ROM had recently purchased a powerful commercial X-ray tube (Sperry) with a digital image capture system (DR) (Carestream Industrex ACR-2000i digital X-ray detector/scanner) for computed radiography (CR). As we had not yet received Ministry of Labour clearance to use our new high-power Sperry head, we decided to proceed using the Philips Muller tube, a lower-energy (kilovolt) machine. Based on experience with exposures from work on other ceramic vessels, we decided to run our preliminary X-rays at 80 kV and 3 mA with a 2-minute exposure, as a starting point.

The set-up was difficult because of complications supporting the radiographic plates vertically behind the body. Our largest digital imaging plate (CR plate) measures 35 cm by 43 cm, but the object is approximately 56 cm high, 38 cm wide, and 41 cm deep. To get a complete image, we shot the object in sections and stitched the sections together. Since image clarity is improved with close proximity to the plate (O'Connor and Sparrow, 2015), the typical set-up would be to have the plate horizontal with the artefact lying just above it. In the end, we decided to hang the plates behind the urn and to support them vertically using retort stands with arms, as the plates are floppy and flexible.

The new digital imaging process is a game changer. With computer radiography, there is no longer the need for sensitive and expensive single-use X-ray film plates that require darkroom prep and development, darkroom developing and drying time, and a darkroom viewer to read the plates. After exposure, the CR plate (bromine/phosphor) is "read" by laser light in the Carestream scanner and the image is visible within seconds on a computer

monitor. Being digital, it can be manipulated using proprietary software which highlights or intensifies areas of interest. Intensity and contrast can be altered so that even dark images are readable. The results can be saved and shared within minutes.

The first images of HM 1953 were eye-opening (Figure 1), and supported many of the results obtained from visual examination. Recall that an object's density and composition determine the shades of gray, black, and white that one sees on the X-ray image. The white areas are those which are most X-ray opaque, either because they are thicker or because they are made of a more radio-opaque material; the black areas are either the thinnest or most radio transparent, allowing the X-rays to penetrate and expose the underlying plate. Our first shots focused on the head and upper torso, and the visibly modified nose which was of greatest concern (Figure 6.1). We see a large black void below the bridge of the nose with "fabric" of various densities filling the nasal area. The proper left ear spool and phalange behind are fragmentary. The proper right ear spool looks intact. Importantly, there is a small vestige of the proper left shoulder to which the shoulder cape is attached. The proper right shoulder cape is broken at the body. Both capes have dark lines running through them, indicating either fractures or hairline cracks. The head's material density, as reflected in the shades of grey over the face, around the mouth, cheeks, eyes and centre upper crown, is fairly uniform.

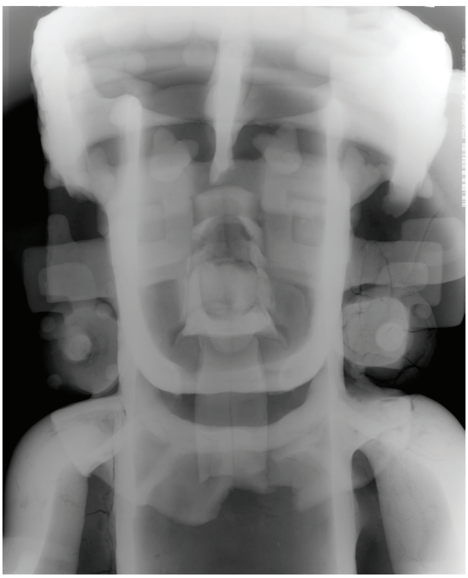
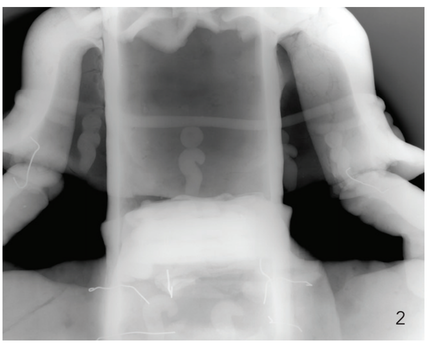


Figure 1: X-ray of HM 1953 Head and Upper Torso.
(80kV. 3mA. 1 min.)

Moving down the torso (Figure 2), we were struck by the arm assemblage on both sides. The fabric of the proper right shoulder cape looks comparable in texture to the body fabric, whereas the proper left cape, as fragmented as it appears, does not look comparable. What is striking are the two bright white noodle-like forms that attach the forearms to the cape. There is no visible join showing that the arms belong, as the area that connects each arm to the cape is quite distinct in shape. The "noodles" are likely modern wires. This was a common twentieth-century repair technique to support joins. The arms appear atrophied and disproportionate. The thick white area at the top of the loincloth represents a view of many pieces overlapping. Again, thin bright lines are visible indicating joins supported by wires.

Figure 3 provides a different view of the loincloth. The loincloth area is again very thick in this image (remember that the urn's crossed legs and loincloth are viewed and shot from the front, where there is a lot of overlapping material). Several wires are also visible in this view as well as two vertical breaks on the proper left leg and a diagonal break on the proper right leg. In the lower base, we see more of the wires used to support the joins of the legs to the cylinder. The relative thickness of the material is comparable to that of the torso, but the fabric appears slightly different in texture. Again, the proper left arm looks as if it was built up from a number of pieces that are not similar to the torso material. The forearms show a distinct half-round profile, a rare feature in Zapotec urns (see Chapter 5). None of the arm joins appear to marry cleanly to one another or match each other, indicating that they do not belong to one another. The loincloth is virtually opaque from this angle, likely due to thickness of material. As it thins to a single layer and falls over the folded legs, the glyphs are clearly visible.



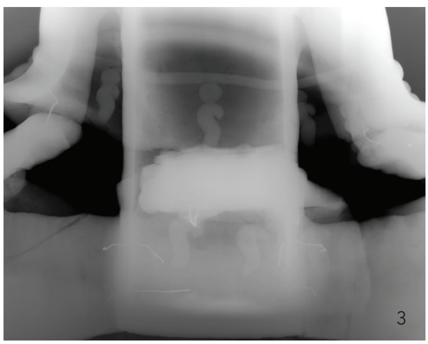
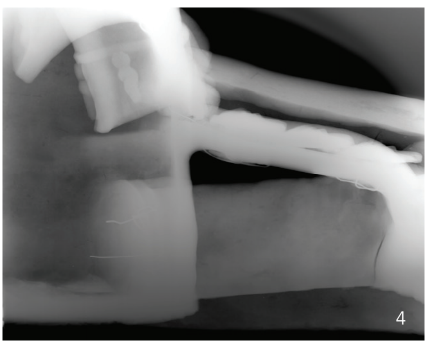


Figure 2: X-ray of HM 1953 Lower Torso. (80kV. 3mA. 1 min.)

Figure 3: X-ray of HM 1953 Lower Torso and base. (80kV. 3mA. 1 min.)

The side view of the bottom torso from the proper right (Figure 4) shows that a slightly thicker piece of ceramic has been used to bridge the gap from the edge of the break of the original loincloth at the torso to a point of attachment at the crossed legs, which is again held in place with wires. What is clear is that the glyphs on the loincloth are extraneous features that lie on top of the bridging material. These pieces bear no physical relationship to one another and may have been placed in their positions to mask repairs. This buildup of material contributes to the white appearance of the loincloth on the X-ray, as the thickness prevents the penetration of the rays to the radiographic plate.

Of all the features, the nose was the most contentious: it was evident that it had been extensively repaired, and it was stylistically different from other known examples in this group. The side view from the proper right shows a clear void over the bridge (Figure 5). Yet there is material with a similar density over the ball of the nose. The X-ray was not able to show if this material is ceramic or an unfired soluble material (see Chapter 11 for a resolution to this question). A long crack is visible in the basket of the urn, running vertically behind the ear spools. Much longer than could be seen by visual inspection, the crack is a structural concern. Looking at the area of the cylinder, you can see horizontal bands of alternating light grey and darker grey. This could be evidence of the flat coil technique used to construct the basket.



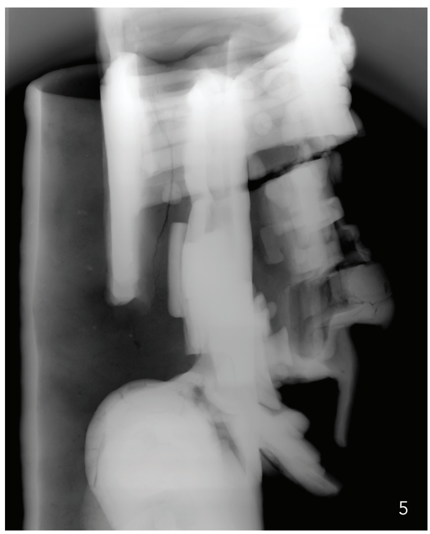


Figure 4: X-ray of HM 1953 pR side, Lower torso. . (80kV. 2.5mA. 1.7 min.)

Figure 5: X-ray of HM 1953 pR profile Head. (80kV. 2mA. 1.5 min.)

X-RADIOGRAPHY

Although several scientists were experimenting simultaneously with a source of electrons from a Crookes tube which emitted ‘rays’ that seemed to pass through matter and fog photographic plates on the other side, it is Willhelm Rathgen who is credited with their discovery in 1895. He named them X-rays, ‘X’ because the source was ‘unknown’, when he published his findings.

X-rays are a form of electromagnetic energy that lie on the electromagnetic spectrum just beyond ultraviolet light energy levels. They have the ability to pass through both a vacuum and most matter including that which is opaque to visible light (O’Connor, 2007: 13). At the other extreme, X-rays will not penetrate lead, due to its high density and atomic number.

As they pass through matter, some of the electrons may be scattered or absorbed by the matter (differential absorption and attenuation). They will have more trouble penetrating denser and thicker material and easily pass through other thinner materials. The result of this differential is captured on a radiographic plate in the same way that light sensitive photographic film will capture an image: the exposed and developed plate registers like a negative image the ability of the electrons to pass through matter; areas that are black are areas that the electron beam passed through easily and can be interpreted as voids or cracks, and areas that are white are radio opaque, made of thicker, denser material. (For a discussion on the four forms of radiation used in radiography, see Lang Middleton, 1997.)

When planning to X-ray an artifact, the operator must take into account the type of material, its density, its thickness; what questions are you posing and what can you hope to see? For instance, are you looking for losses or evidence of mechanical failure? Are you hoping to see inside an object, perhaps with a core or an armature?

The quality of the image is affected by 4 exposure variables or parameters: kilovoltage (kV), milliamperage (mA), time and distance of the object from the tube, and the operator must select among these variables to get the best image. The kV represent the strength of the beam and dictate the level of penetration of the beam. The mA affects the level of contrast and is in direct ratio with Time or the amount of exposure for which the beam is released. Depending on material composition and thickness, the operator will vary the settings to optimize the quality of the image. Unlike medical and dental X-rays, where the amount of energy used is limited by health and safety concerns and standardized by the consistency of tissue character throughout our species, artifacts can vary in composition, technique, decoration, deterioration and subsequent alteration and therefore, the settings used to X-ray the material can vary substantially. It is rare to be able to take a perfectly informative object X-ray with one exposure. Humans could not tolerate the repeated exposures we use to fine-tune an image.

Commercially, examination of everything from pipelines to aircraft has become fairly standardized and mechanized. But there are techniques that can help to improve image quality. These include filters and screens to filter random rays and absorb scatter, helping to create a sharper clearer image. Image quality indicators can be incorporated into the image to indicate level of penetration and contrast so that settings can be changed to improve image quality. The use of X-radiography and zero-radiography in the study of ceramics is discussed thoroughly in Berg (2008) and Lang & Middelton (1997).

Training, skill, and experience is required not only to take a good radiograph, but also to interpret what you see. Understanding how materials affect the radiograph and understanding the materials themselves will heavily influence your final understanding of what you are able to observe.

It is not often that one can compare the "before and after" images of an object. In Figures 6a, 6b, and 6c we see the nose from the proper right side of the urn at different stages in the process: as it appeared during original visual examination, before any testing (6a); in an X-ray (6b); and after the removal of the soluble filling. The lower section of the urn had to be shot in two halves (Figures 7 and 8), because the plates were not large enough to cover the piece in one shot. The fragmentary state of the arms and hands is again striking in these shots. The thickness in the area of the loincloth is again noticeable.

It is difficult to comment on fabrication or construction techniques based on these X-ray images because the layouts were designed to answer questions about joins, repairs, and most importantly the construction of the nose. However, as noted above, the basket area shown in Figure 5 shows evidence of stacked flat coiling represented by the light grey and black horizontal banding. None of the other X-ray images show this banding in the flat ceramic areas of the leg (Figures 2, 3, 4 and 8) where they attach to the basket.

In conclusion, the X-rays performed on HM 1953 further illuminated the extent to which the piece had been altered. Questions of filling/repair prompted by the visual examination and the use of other optical techniques were confirmed by the X-ray images, which also indicated their probable extent. Yet, our results illustrate the limitation of the technique as we used it. If time had permitted, we could have focused more on the join between the cylinder and legs using other settings and filters to discern more detail. If it had been available to us, xeroradiography, a technique that uses a specially coated charge plate to more clearly define materials of different densities, may have revealed further details of the nose. Only so much data can be obtained via two-dimensional X-rays of three-dimensional objects with overlapping elements. To better visualize joins and other aspects of HM 1953, we needed computed tomography (CT).

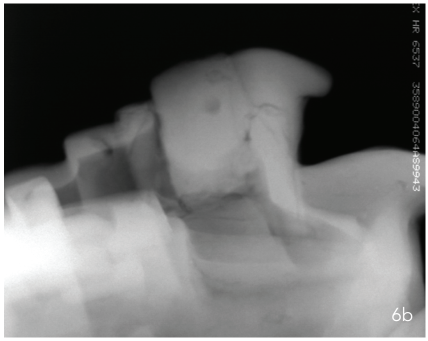




Figure 6a: HM 1953 detail of pR nose, before.

Figure 6b: X-ray detail of HM 1953 pR nose. (80kV. 3mA. 1 min. small plate 29/6/2016).

Figure 6c: HM 1953 detail of pR nose, after deconstruction.

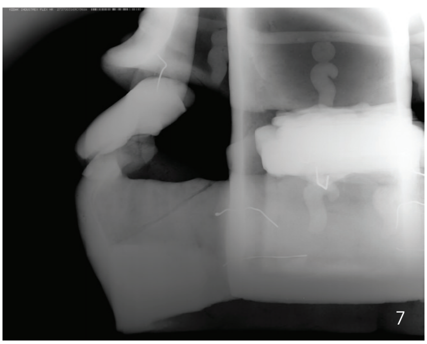
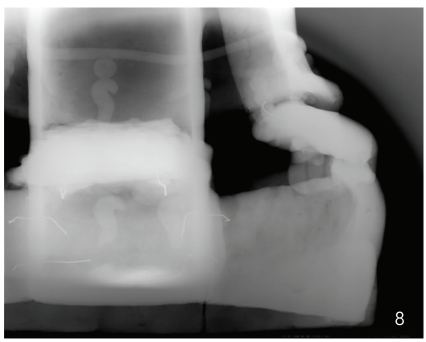



Figure 7: X-ray of HM 1953 pR base and hand. (80kV. 2.5mA. 1.7 min.)

Figure 8: X-ray of HM 1953 pL base and hand. . (80kV. 3mA. 1.5 min.)

References Cited

Berg, Ina. 2008. "Looking Through Pots: Recent Advances in Ceramics X-radiography." *Journal of Archaeological Science* 35:1177–88.

Bortolot, Victor J. 2016. "Thermoluminescence Dating of Art Objects." Accessed February 8. "://daybreaknuclear.us/bortolot_daybreak_frameset.html.

Craddock, Paul T. 2009. *Scientific Investigation of Copies, Fakes and Forgeries*. Burlington: Butterworth-Heinemann.

Fell, V., Q. Mould, and R. White. 2006. *Guidelines on the X-radiography of Archaeological Metalwork*. Historic England. Edited by English Heritage: Swindon: English Heritage.

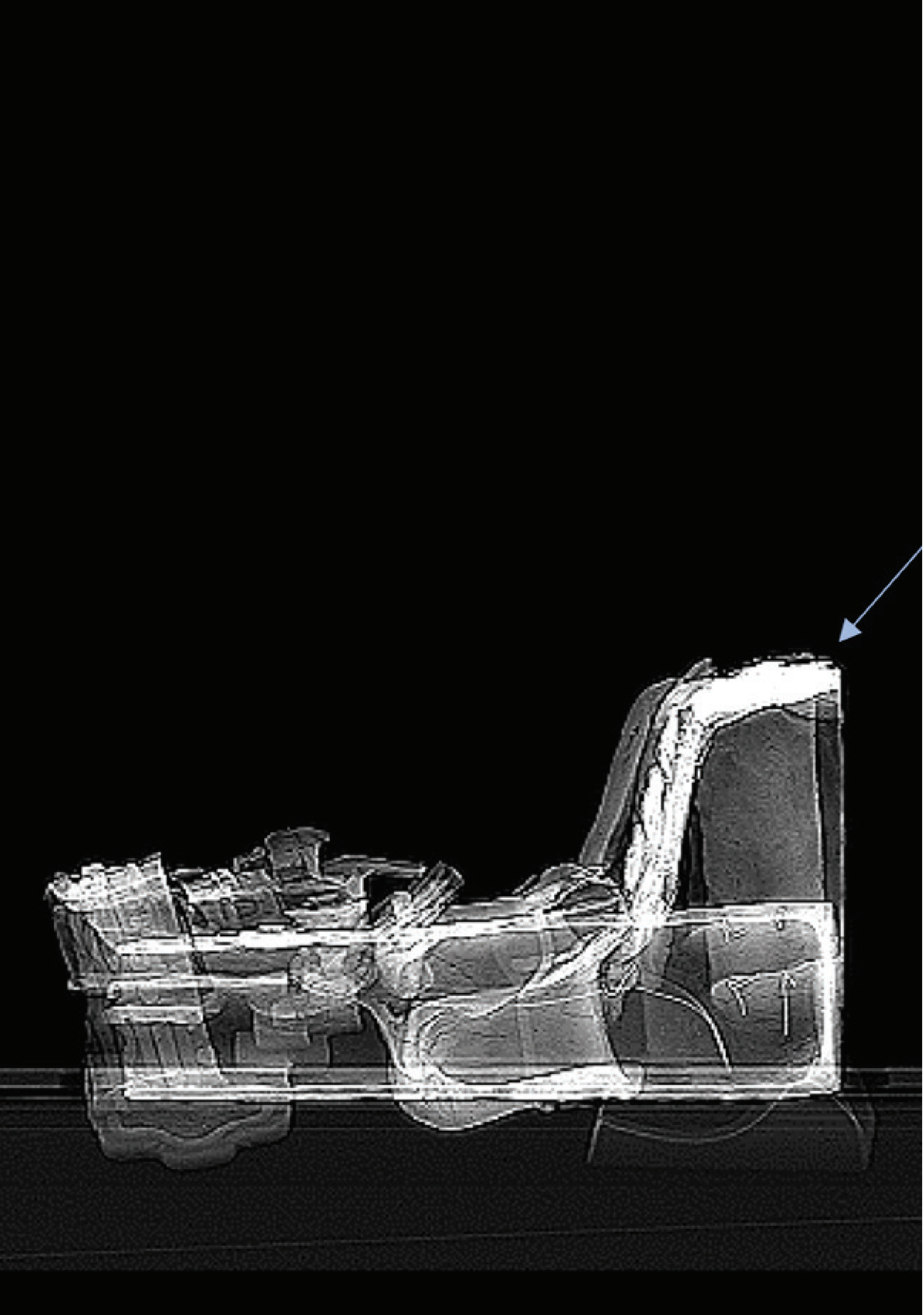
Green, Alan, and Charles Hartley. 2007. "From Analog to Digital: Protocols and Program for a Systematic Digital Radiography of Archaeological Pottery." In *Proceedings of the Conference EMAC '07, 9th European Meeting on Ancient Ceramics, 24–27 October 2007*, edited by K. Biró, V. Szilágyi, and A. Kreiter, 5–14. Hungarian National Museum, Budapest.

Lang, Janet, and Andrew Middleton. 1997. *Radiography of Cultural Material*. Boston: Butterworth-Heinemann.

O'Connor, Sonia, and Tom Sparrow. 2015. *X-radiography of Cultural Materials Workshop*, Workshop Notes, ROM, May 2015.

O'Connor, Sonia A., and Mary M. Brooks. 2007. "X-radiography of Textiles, Dress and Related Objects." In *Butterworth-Heinemann Series in Conservation and Museology*, 1st edition. Amsterdam: Butterworth-Heinemann.

Watson, Jacqui, Vanessa Fell, and Jennifer Jones. 2008. *Investigative Conservation: Guidelines on how the Detailed Examination of Artefacts from Archaeological Sites can Shed Light on their Manufacture and Use*. London: English Heritage Publications.



CHAPTER 7

Computed Tomography Scan

SHAWN STAPLETON / HARVARD UNIVERSITY
HEIDI SOBOL/ ROYAL ONTARIO MUSEUM

CT Scanning in Cultural Heritage

Computed tomography (CT) scanning is a non-destructive, three-dimensional (3-D) imaging method that was used to digitally explore and analyze Zapotec urn HM 1953. CT allows for detailed analysis of the internal structure of the urn, including its dimensions, shape, material defects, and material density. CT has been a singularly powerful tool for in-depth radiological studies and analysis of a wide array of cultural and archaeological objects. For example, CT imaging has been crucial in identifying pathologies in Egyptian and non-Egyptian mummies (Appelboom and Struyven 1999; Cesarani et al. 2003; Harwood-Nash 1979; zur Nedden et al. 1994) and the structure of bronze artefacts, such as Etruscan cremation urns (Rossi et al. 1999). The digital nature of CT imaging allows museums to virtually manipulate an object in ways they could not otherwise, thereby revealing new dimensions and allowing for unprecedented exploration. In this chapter we provide a fundamental picture of HM 1953 beyond what is possible using traditional planar X-ray imaging.

The decision to use CT imaging was driven by prior X-ray imaging of HM 1953 that suggested the piece had previously been damaged and undergone restoration (see Chapter 6). An X-ray image renders the urn in two dimensions, making interpretation of its geometry, materials, and construction difficult. Because the urn material is homogenous (almost entirely ceramic, save for the metal wires), X-ray images also offer little contrast between the different segments of the artefact. CT scanning provides a more fundamental view of HM 1953, allowing improved discrimination of the segments, losses and marks, and material properties within the artefact.

CT imaging was first used for medical purposes but has since been adapted for use by the cultural sector (see What Is CT Scanning?). In the early days of CT scanning, investigative scans of mummies—both human and animal—

WHAT IS CT SCANNING?

CT scanning—sometimes referred to as "cat scan"—is the abbreviated term for computed tomography scanning. It is also interchangeable with the term computerized axial tomography (CAT). A CT scan is the accumulation of hundreds of two-dimensional xray scans, organized in such a way to create a three-dimensional representation of the object being scanned. Think of an X-ray as a slice of bread—a CT scan is a loaf of bread, made up of many slices of bread arranged in a systemized format.

The medical industry is the primary user of CT scanning, as it is very helpful in imaging the relationships between tissues, organs and bones within living creatures. However the cultural sector has been able to adapt CT scanning for almost 40 years to image the internal structure of art and artifacts. Most often it is used on mummies and other encased materials—artifacts that cannot be physically deconstructed due to preservation issues or, on occasion, religious reasons that forbid the disruption of the enclosure, such as African reliquary figures with bwete (baskets).

The ROM holds the titles of the first cultural institution in the world to CT scan a whole mummy (Djedmaatesankh, ROM 910.10) in 1977, and the first to scan the internal structure of mummy tissue (Nakht, ROM 910.4) that same year. The CT scanning of HM 1953 maximizes the qualitative potential of interpretation, shedding new light on the physical composition of the urn.

Box 1.1: HM 1953 in situ at CT scan site, November 2016.

Box 1.2: May 1994 CT scan of profile of Djedmaatesankh, ROM 910.10.

had a pivotal impact on the evolution of non-destructive analysis of cultural artefacts. The shift away from autopsies and toward comprehensive imaging by X-radiography and CT scanning led conservators and archaeologists to give more credence to the philosophy of "do no harm." Shortly after CT scanning of remains was adopted, its application to the investigation of ceramics blossomed.

While absorption of the X-rays in silicate bodies can render a low-contrast image, the aplastic constituents of archaeological ceramics—particles like non-clay minerals or rock fragments—may produce greater contrast. As noted above, the homogeneous nature of clay bodies makes it difficult to interpret X-rays of ceramics. CT scanning, which is able to use the 3-D rendered aplastic constituents to build structure, produces a more easily interpreted image. The differentiation in a rendered CT scan can show material construction, damages, repairs, and clay body differences.

CT scanning of ceramics has provided researchers and historians with key information about many types of artefacts. For example, Mesopotamian clay tablets (also known as cuneiform tablets) were sometimes encapsulated in a clay envelope that prevents the tablet from being read. Examples of such tablets are prevalent from the Ur III Dynasty (Sumerian region circa 2004 BCE; currently Iraq) and can be found in hundreds of collections throughout the world. Because breaking the envelope to reveal the text inside is not an option, and X-radiography cannot adequately differentiate between the clay envelope and the delicate inscriptions on the inner clay tablet, CT scanning is the optimal solution. Institutions like the Hebrew University (Applbaum and Applbaum 2005) have used CT scanning to render the text inside the clay tablet without having to breach the envelope. Using tailored algorithms to compile the data from the CT scanning, images of the texts are then presented to the researcher for interpretation.

While CT scanning of ceramics is becoming more prevalent, xeroradiography was the predominant choice for several decades. Xeroradiography uses an electrostatically charged plate instead of radiographic capture (film or a detector). The plate operates on principles similar to those of a photocopier: an image is created based on particle contrast but using X-radiation rather than light. When applied to ceramics, xeroradiography was very useful in that the images generated had highly contrasted borders within the artefact image—perfect for highlighting construction techniques (slab, coil, or wheel-thrown) as well as aplastic particle distribution. Unfortunately, xeroradiography fell out of use in the medical industry, thereby becoming less accessible to the cultural sector, and is no longer widely used.

In this project, we used state-of-the-art CT technology to explore and digitally deconstruct the Zapotec urn—to create a map, if you will, to aid conservator Laura Lipcsei during deconstruction.

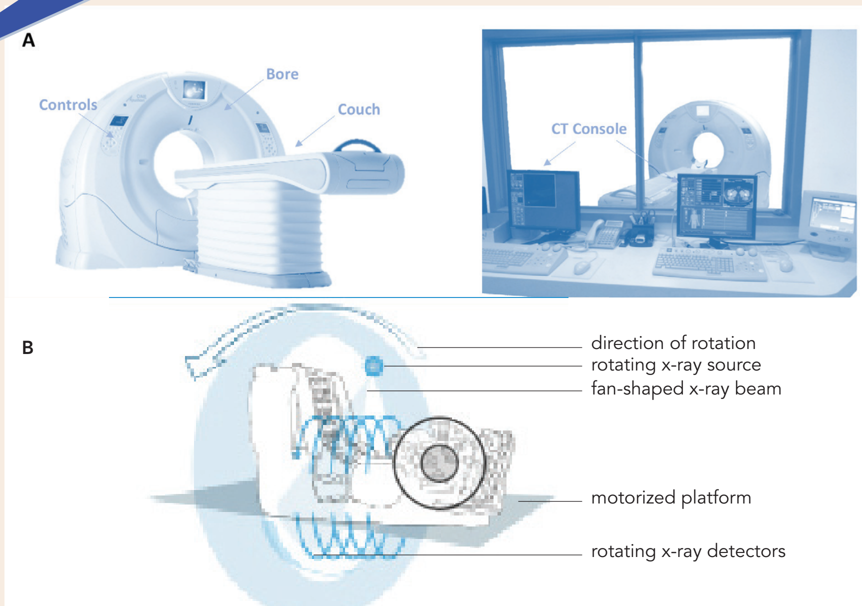
CT Imaging of HM 1953

Scanning the Zapotec urn required some special considerations that made it very different from a standard patient radiological scan. First, transporting the urn to the hospital CT scanner at Princess Margaret Hospital in Toronto required that it be carefully and properly packaged, and a custom case was designed for this purpose. Second, the size and shape of the urn reached the limits of the detectable region achievable with the hospital CT scanner (Aquilon One, Toshiba, Japan). Therefore, the urn was carefully physically manipulated to ensure complete acquisition in one scan. A scout image was taken to set the region for CT scanning. A helical scan was then performed using an X-ray energy of 120 kVp and a tube current of 300 mA. The 2-D projection data was reconstructed using an algorithm optimized for high-density structures, such as bone. The CT scanner produced a 3-D image of the Zapotec urn that was 499 × 443 × 584 mm in dimension, comprised of 512 × 512 × 1169 pixels, giving a resolution of 0.98 × 0.98 × 0.5 mm. A detailed overview of the CT imaging methodology is given in Fundamentals of Commuted Tomography. After acquisition, the digital images were transferred to a workstation for viewing and analysis.

FUNDAMENTALS OF COMPUTED TOMOGRAPHY

CT imaging of world culture and natural history artefacts typically involves the use of a clinical CT scanning system located within a hospital, private clinic, or, to a limited extent, a museum. A CT scanner is comprised of several key components: the bore, which often looks like a donut, houses the equipment used to emit and detect X-rays; the couch provides a surface for the object to sit on and be inserted into the bore; onboard controls are used to align and position the object within the bore; and a console located outside the room is used to safely operate the CT scanner without the technician experiencing prolonged exposure to X-rays (Box 2.1a). The bore of the CT scanner contains an X-ray tube (to generate X-rays) and a digital detector (to visually render the X-ray data onto a computer screen, as an image file). Both the X-ray tube and detector can be rotated around the specimen while it is moved into or out of the CT scanner using the couch (Box 2.1b).

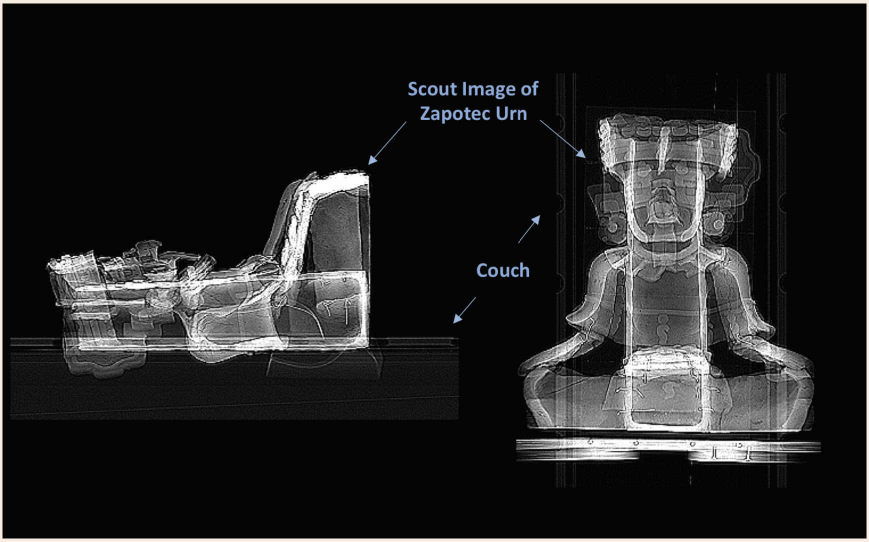
Scanning an object is no different from scanning a patient. A technician places the object on the couch, carefully aligns the object within the bore using the controls, and then enters the console room to continue setting up for the scan. The first stage of scanning involves take a "scout" image that typically consists of two perpendicular



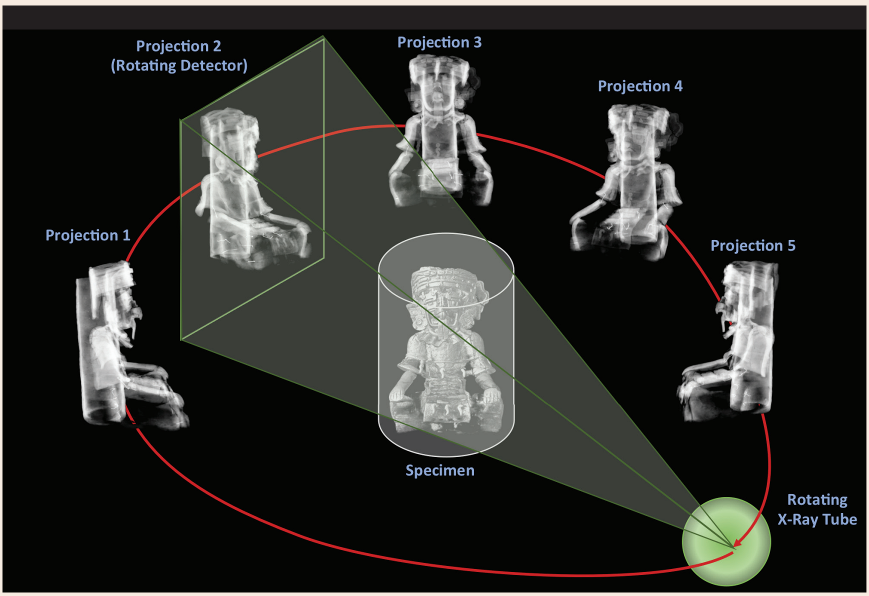
Box 2.1: Anatomy of a CT Scanner. (a) A representative image of a clinical CT scanner showing the bore, couch and controls. The x-ray tube and detector are housed in the bore and rotates around the object, collecting images from multiple angles. (b) The CT scanner is operated from a shielded control room, with the CT technician operating the system via the CT console. (c) This diagrammatic representation depicts the object is moved through the bore using the couch, allowing for the collection of images from multiple locations.

2-D X-ray scans (Box 2.2). These scans are used to define the region of interest to be scanned in 3-D and to ensure the selection of optimal imaging parameters (see discussion below). The second stage involves initiating the CT scan, whereby a series of 2-D X-ray images are collected and processed by the CT console computer to generate a 3-D digital representation of the object.

The 2-D X-ray images are taken at different angles around the object, by rotating the X-ray tube and digital detector around the specimen while it moves through the CT scanner (Box 2.3). This scanning configuration is termed a "helical scan" and is one of several modes of data acquisition achievable by modern CT scanners. In our experience, helical scanning produces the least amount of geometric distortion of the sample and is ideal for imaging world culture pieces. Each 2-D X-ray scan is referred to as a "projection" and is a measurement of the number of X-rays that were able to penetrate the object along a specific trajectory (Figure 7.9). Bright regions on the image show the object's density and/or thickness, while dark areas show where the X-rays have penetrated efficiently (Box 2.3). It might seem counterintuitive that bright regions represent fewer X-rays; however, this is simply a convention and signifies our preference to denote bright regions as having higher density or a thicker amount of material compared to darker regions. This also highlights our ability to manipulate and represent the digital data in a manner that suits our needs.



Box 2.2: Scout Image of Zapotec urn used to define region for the high-resolution CT scan and set optimal CT scan imaging parameters.



Box 2.3: The X-ray tube and digital detector are rotated around the specimen. A series of 2D X-ray scans, called 'projection', are acquired. Each projection is a measurement of the intensity of X-rays that were able to penetrate the object. Bright regions indicate X-rays that are not able to penetrate efficiently, signifying the object in this region was dense and/or thick.

In total, several hundred 2-D projection images are collected. The projections are combined mathematically, using a technique called filtered back-projection, to create a 3-D representation of the object. In general, the more projections collected, the higher the quality of the resulting image, and the better able we are to see different structures clearly. The ability to turn a series of 2-D projection images into a 3-D image is a problem of geometry and not particularly challenging to understand, but is beyond the scope of this chapter. For a conceptual understanding, we invite readers to search online for videos that explain the back-projection reconstruction algorithm. (Several excellent videos are available on YouTube.)

Several parameters can be manipulated when performing a CT scan, including the X-ray energy, the current of the X-ray tube, exposure time, couch speed, and the properties of the image detector. Ultimately, the goal is to generate a 3-D image that has sufficient contrast between areas to distinguish between different densities and sufficient image resolution to be able to see small structures.

The choice of X-ray energy is critical for image quality, and modern clinical CT scanners use X-ray energies between 80 and 160 kVp (peak kilovolts). X-rays in this range are able to penetrate and be absorbed by soft tissues and bones. When it comes to imaging dense materials like ceramics, an X-ray energy of at least 120 kVp is ideal. At this energy, most X-rays penetrate the object and reach the detector, while some X-rays are absorbed or scattered in highly dense regions. If the X-ray energy is too low then the X-rays will mostly be attenuated by the object and nothing will the detected, resulting in a dark/blank image.

The X-ray tube current dictates how many X-rays are produced at any moment in time. When it comes to scanning a patient, the X-ray tube current must generate enough X-rays to produce a high-quality image, while not exposing the patient to more X-rays than absolutely necessary. When it comes to scanning artefacts, there is no such restriction and a high tube current is typically used. If the tube current is too low, the resulting image will have low contrast and appear noisy (similar to a fuzzy TV screen).

The exposure time, couch speed, size of the detector's pixels, and sensitivity all affect the ability to capture X-rays and turn them into a detectable signal. There are other factors that affect image quality, specifically how the images are reconstructed, but this falls outside the purposes of this chapter. It is sufficient to understand that when performing at CT scan of ceramic artefacts, a high X-ray energy, ample tube current, relatively long exposure time, and slow couch speed are desirable parameters. The properties of the X-ray detector are configured by the manufacturer and cannot be manipulated; however, most modern CT scanners have sufficiently sensitive detectors and can achieve a resolution on the order of a few hundred microns (similar to a thick piece of hair).

Visualization and Analysis of HM 1953

The Zapotec urn data was visualized and manipulated using a commercially available software package (Amira, FEI Visualization). Figure 1 shows three orthogonal 2-D slices through the 3-D data set. The Zapotec urn can also be digitally rendered to clearly visualize its outermost surface, almost like a photograph. A comparison between the 3-D surface rendering and the photograph of the Zapotec urn shows the remarkable surface detail captured by the CT scan (Figure 1). Clearly visible on the 3-D surface rendering are the ornamentation of the headdress, face, ear spools, undulating collar (including the missing section), cape with ornamentation, arms with fingers, loin cloth with ornamentation, and legs, including the feet and toes. While the 3-D surface rendering and photograph provide comparable structural information, only the photograph shows surface pigmentation in the urn. This is because visible light is both reflected and scattered by an object's surface, giving the appearance of pigment, whereas X-rays are highly energetic and penetrate an object's surface. CT images do not provide colorimetric information about an object's surface, only structural information. The CT scan is rendered in black and white, and any variations in tone are based on the components of the artefact and have no correlation to pigmentation (unless the pigment has radio-opacity due to the presence of metal).

Figure 1: CT visualization of the Zapotec urn. The 2D images demonstrate the ability to visualize the density of materials used to construct the Urn. The 3D surface rendered data reveals remarkable structural surface detail, comparable to a photograph.

CT scanning allows us to estimate both the surface and internal density of the Zapotec urn. Density provides insight into the use of different construction materials and time-dependent changes in material density; both of these properties may indeed suggest regions of damage, as well as repair/restoration and additions to the urn. A 3-D surface rendered map of the relative density revealed several regions with higher-than-average surface densities: the tongue, nose, eyes, proper left ear spool, cape and loin cloth ornamentations, and cylinder (Figure 2). Conversely, the legs, loincloth, and upper left headdress phalange had lower-than-average density. Note that the ear section is composed of three parts: headdress phalange, ear, and ear spool. In addition, several cracks are apparent along the left and right shoulder regions of the cape, and along the area between the headdress phalange and the ear. These variations in surface density challenge the congruency of the object and suggest the presence of several repairs and additions.

Through further analysis, it is possible to appreciate the internal density of the Zapotec urn using a 3D rendering method called maximum intensity projection (MIP, Figure 3). Immediately apparent are several wires that weave through the arms, loincloth, and legs of the urn. In addition, an abundance of heterogeneously scattered mineral deposits are visible within the fired clay (as bright white spots and splotches). Note the relatively few mineral deposits in the

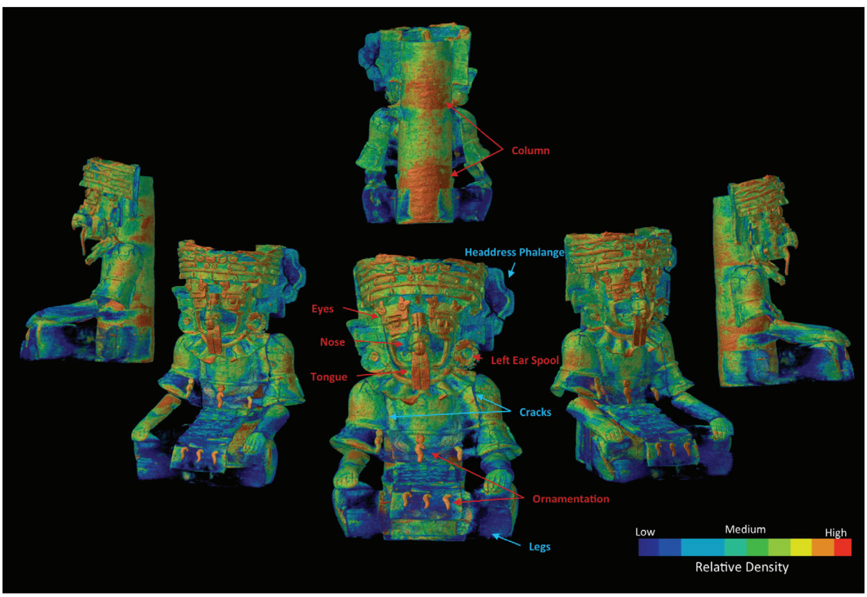


Figure 2: 3D Visualization of the Zapotec urn showing surface variations in the material density used to construct the Urn. Red represents high-density material, while blue represents low-density material.

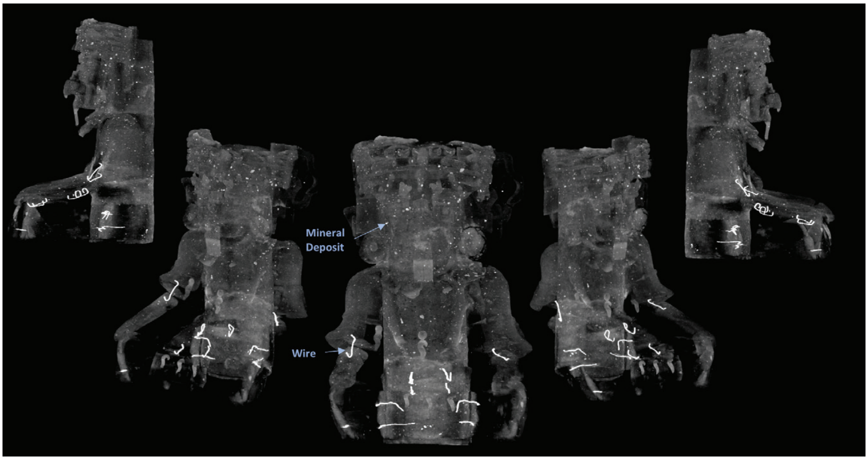


Figure 3
CT Scanning can be used to look inside the Zapotec urn and investigate the types, quality and purity of material used. In this case there is substantial heterogeneity in the type and purity of material. The tongue and left ear spool appear much brighter, speckles of mineral deposits are distributed throughout the urn, and metal wires can also be seen.

left arm and the legs, suggesting these structures were not necessarily part of the original iteration of the urn. Conversely, an abundance of mineral deposits are visible along the column and headdress (but not the phalange). Both the 3-D surface density and subsurface density data sets suggest the majority of the urn has undergone repairs and additions, namely the tongue, left ear spool, upper left headdress phalange, nose, base, arms, and cape.

The surface and subsurface 3-D visualization of the Zapotec urn indicates regions suspected of repairs and alterations throughout the artefact's history. Further exploration and analysis of the CT image data will provide evidence supporting or refuting these suspected modifications. Through analysis of structural features including joints, cracks, and texture, we aim to reinforce our understanding and perhaps identify new regions of repair or additions. Looking closely at the CT data, we see clear evidence of repair (Figure 4). The shoulder regions of the cape show clear differences in density and a lack of fluidity in architecture between the shoulder and column. The crack between the cape and column is most apparent in a cross-sectional view of the urn. Furthermore, cracks and repairs are visible throughout the cape. The nose and tongue also shows signs of being additions to the urn. Specifically, the nose appears to be an additional piece moulded to the face. This is apparent in the disjoint architecture between the nose and face. Most intriguing is that the nose tip does not appear to have the same density as the rest of the nose. Once in the lab, it was noted that the tip is

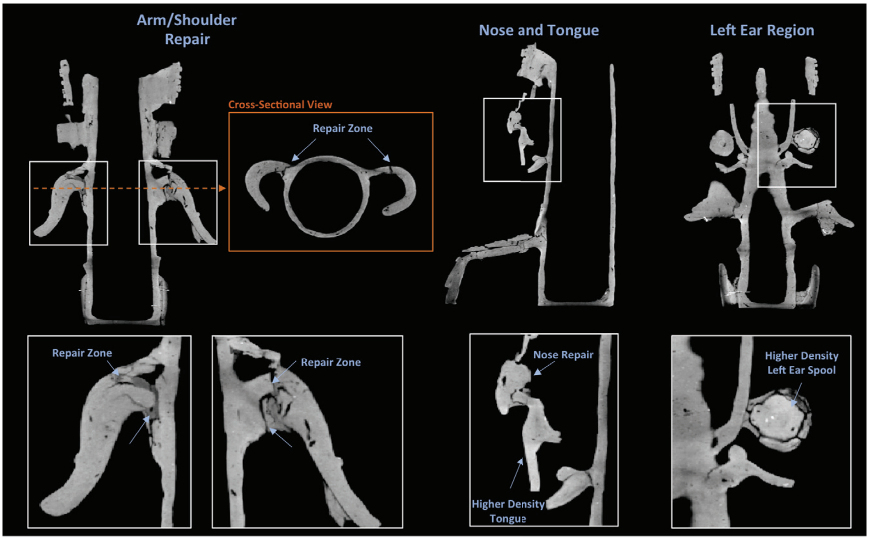


Figure 4: Identification of regions where the Zapotec urn is suspected to have undergone repairs. These regions were identified by looking at differences in brightness (density), suggesting different ceramic materials were used for repair, and for structural joint damage, suggesting the attachment of a new object.

actually a non-fired, very soluble ceramic while the main portion of the nose is fired and not soluble. The density of the tongue is incongruent with the density of the surrounding face, suggesting the tongue is an addition. A smooth transition between the face and tongue suggests expert repair. Additionally, the left ear spool has a higher density and disjointed geometry compared to the right ear spool, suggesting a new addition to the piece. Further analysis of the CT data shows cracks and disjointed architecture throughout the Zapotec urn, corroborating earlier observations that the tongue, left ear spool, left ear phalange, nose, legs/base, arms, and cape are repairs and additions.

The previous analysis of the gross differences in density, mineral deposits, and cracks were used to deconstruct the urn into its constituent components (Figure 5). The deconstructed components were analyzed quantitatively and compared to each other to determine their similarity in density and mineral deposits. Using the column as a reference density, we found a wide variation in the relative density and mineral deposits among the components (Figure 6). For example, the tongue, nose, and left ear spool had a density 13%–15% greater than the column. Correspondingly, the tongue, nose, and left ear spool had the highest density of mineral deposits. Several of the decorations on the cape and loincloth also had a high relative density; however, these objects had virtually no mineral deposits. The density of the column was similar to that

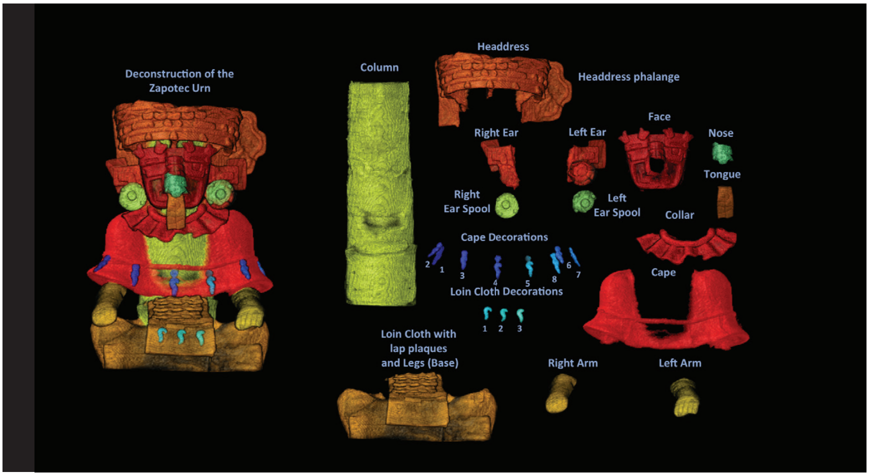


Figure 5: The Zapotec Urn was digitally de-constructed to visualize and appreciate the manufacturing process and region repairs. De-construction also facilitates the analysis of material properties for the individual components.

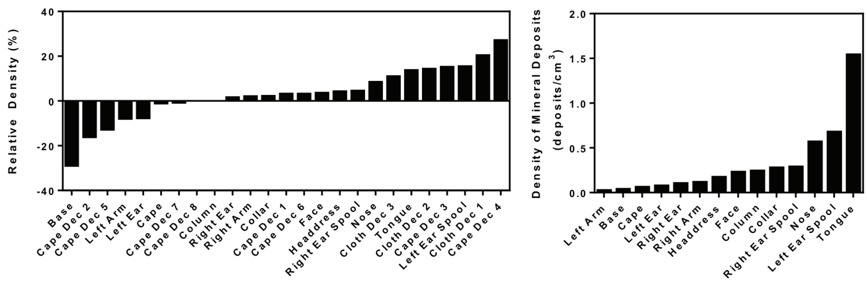


Figure 6: Analysis of the Relative Density and Mineral Deposit Density of the different components that comprise the Zapotec Urn demonstrate a wide variation in material properties. Regions such as the base and left arm have substantially lower densities and mineral deposits compared to the tongue and nose. This further corroborates the differences in materials used and construction processes.

of the headdress, face, collar, right ear spool, left/right ear, and cape. Only the headdress, face, collar, and right ear spool had comparable mineral-deposit density to the column indicating these objects were created using similar materials and fabrication process. Interestingly, the left and right arms had different densities. The loincloth and legs consistently had the lowest density and mineral deposits of all the components. The quantitative analysis suggests that different materials, fabrications processes, or fabrication times were involved in creating the various components of the Zapotec urn.

Summary

CT scanning provides valuable information about the construction of an object. It is a quantitative and qualitative resource that aids the eye in understanding the entire structure. In the case of Zapotec urn HM 1953, CT scans informed our interpretation of structure, fabrication, damage, and repairs. In the scheme of non-destructive, CT scanning is quick but should not be used in isolation: only alongside the results of other investigative techniques can theories be proposed and then promoted. In this project, we were able to digitally deconstruct the urn based on variations in surface density and discontinuity in the structural interfaces of different regions. We found that the urn is constructed from multiple components, some original and some repairs and/or additions. For example, the column was deemed original along with the collar, central cape, and right headdress phalange, face, ear spool. Analysis using thermoluminescence (TL) dating will further elucidate the sequence of repairs and additions to the urn.

References Cited

Applbaum, N., and Y. Applbaum. 2005. “The Use of Medical Computed Tomography (CT) Imaging in the Study of Ceramic and Clay Archaeological Artefacts from the Ancient Near East.” In *X-rays for Archaeology*, edited by M. Uda, G. Demoriter, and I. Nakai, 231–45. Springer

Appelboom, T., and J. Struyven. 1999. “Medical Imaging of the Peruvian Mummy Rascar Capac.” *The Lancet* 354 (9196): 2153–5.

Beckmann, E. C. 2006. “CT Scanning the Early Days.” *The British Journal of Radiology* 79 (937): 5–8.

Cesarani, F., M. C. Martina, A. Ferraris, R. Grilleto, R. Boano, E. F. Marochetti, A. M. Donadoni, and G. Gandini, 2003. “Whole-Body Three-Dimensional Multidetector CT of 13 Egyptian Human Mummies,” *American Journal of Roentgenology* 180 (3): 597–606.

Harwood-Nash, D. C. 1979. “Computed Tomography of Ancient Egyptian Mummies.” *Journal of Computer Assisted Tomography* 3 (6): 768.

Rossi, M., F. Casali, P. Chirco, M.P. Morigi, E. Nava, E. Querzola, and M. Zanarini. 1999. “X-ray 3D Computed Tomography of Bronze Archaeological Samples.” *IEEE Transactions on Nuclear Science* 46 (4): 897–903.

zur Nedden, D., R. Knapp, K. Wicke, W. Judmaier, W. A. Murphy Jr., H. Seidler, and W. Platzer. 1994. “Skull of a 5,300-Year-Old Mummy: Reproduction and Investigation with CT-Guided Stereolithography.” *Radiology* 193 (1): 269–72.

CHAPTER 8

Thermoluminescence

ÁNGEL RAMÍREZ LUNA / UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO

The visual inspection of HM 1953, combined with X-ray and CT scanning, revealed that the object is composed of various restored and added parts, but what can we say about the relative age of those parts? Was any piece of the urn manufactured in pre-Hispanic times or does the entire assemblage belong to a more contemporary period? To answer these questions, we needed to date the various parts of the urn to determine if the parts were later additions or material belonging to the moment the urn was originally made. In this chapter we explore the object's relative age using thermoluminescence (TL), a technique that has been used to date art objects since the 1960s (Fleming 1975).

Thermoluminescence ("heat–light") can be explained as follows: when certain crystalline solids are irradiated with ionized radiation and then heated, the solids emit photons in the form of visible light. The name for the process is thermally stimulated luminescence, or thermoluminescence, the latter of which is the name most commonly used (Bortolot 1994, 81). At an atomic level, the ionized radiation interacts with the electrons of the atoms within the molecular structure of the solid. The electrons excite each other and pass to another level of energy, where they are "captured" in the crystal in a metastable state. When the solid is heated, the trapped electrons are freed and return to their original elemental state of energy. The excess energy produced in this heating process can be measured as a luminescent signal (Figure 1).

Naturally occurring radioisotopes are present everywhere—in stone formations, in the dunes of a desert, in our patios and gardens, and even within living beings. The most abundant radioisotopes in nature are uranium (^{238}U), thorium (^{232}Th), and potassium (^{40}K). These elements have half-lives of many millions of years, which is why they are considered constant sources of radiation. Radioisotopes are also detectable in the minerals found in ceramics. Hard and durable, ceramics are an abundant cultural material in the archaeological context, and TL dating can be used to pinpoint the moment a

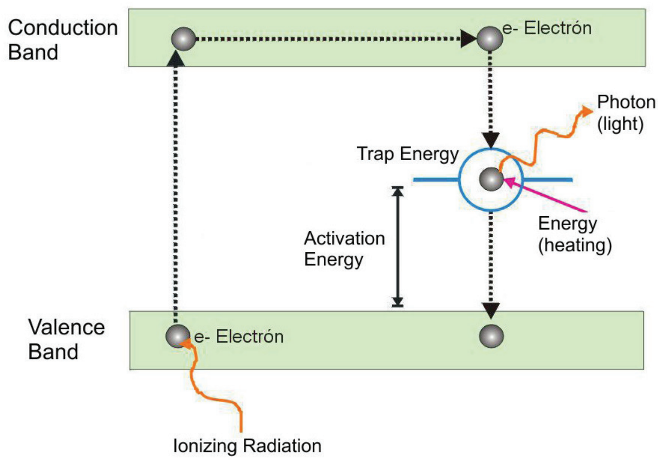


Figure 1: Model of bands of energy that explains the pehnomena of thermoluminescene.

ceramic artefact was fired. Firing temperatures often exceed 500°C, returning electrons to their elemental state. When the ceramic object has cooled, the minerals inside again receive doses of natural radiation. Excited electrons get trapped once again in the matrix until they are heated and released. In effect, the TL clock is restarted when a ceramic object is fired.

Depending on their condition, ceramic samples retrieved from controlled archaeological contexts can be dated with precision using the TL method; when the artefact is discovered *in situ*, the surrounding earth is comparatively analysed for concentrations of uranium, thorium, and potassium. The exact find spots of museum objects, however, are not often known, and it is very rare to have soil associated with their discovery. Although the resulting dates for such objects are less precise, one can still determine whether an artefact is of ancient or recent manufacture. For this reason, TL is a fundamental tool of museums, collectors, and academic institutions that seek to establish the antiquity of the objects they possess, exhibit, or study. Since the particular molecular structure of some minerals cannot house a luminescent signal, not all ceramic samples analyzed by the antiquity test will show definitive results.

Methodology

Generally speaking, the area from which a TL sample is taken depends on those who are ultimately responsible for the object, given that the intervention can alter the artefact's aesthetic. For this reason a ceramic artefact is most commonly sampled either on its base or in an unseen interior section. To

determine which areas should be sampled on objects that have been restored, a visual analysis using different types of light sources is required.

Sample regions of HM 1953 were chosen in close consultation with object conservator Laura Lipcsei and researcher Adam Sellen. The selection process was based on a visual inspection of the object in natural and UV light, where it was clear that parts had been added or restored because of the relative darkness of the clay, as well as from visible signs of exfoliation, fissures, and repairs, i.e., the nose, arms, legs, and shoulders. Other parts of the object, such as the base of the cylinder and a section of the headdress, appeared to be part of the original ancient manufacture. The parts that seemed ancient were also tested so that they could be compared to those parts that appeared to have been added later.

Sellen and I took perforations made with a tungsten-carbide-tipped drill, approximately 4 mm in diameter by 5 mm deep, at eight predetermined areas of the urn (Figures 2a and 2b). Since sampling leaves a small hole in the artefact, when possible we attempted to drill in areas that were not visible. A sample of approximately 60 mg was taken in low-light conditions and stored in a lightproof container to avoid loss of the TL signal.

Figure 2: Some sampling points, a) right arm, b) nose.

THERMOLUMINESCENCE ANTIQUITY TESTS ON ZAPOTEC URNS

There have been several TL studies carried out on large museum holdings of Zapotec urns. Shaplin and Zimmerman (1978) published results of a study on over a hundred urns in the Morton May collection at the Saint Louis Art Museum, as well as selected pieces at Harvard's Peabody Museum and the Royal Ontario Museum. The TL testing of these collections was used to corroborate art historical approaches to identifying spurious material based on a predetermined set of visual attributes. Zimmerman also carried out zircon-inclusion dating on three of the suspect pieces to rule out the possibility that the objects had been artificially irradiated. This method is employed in authenticity studies where outside radiation is suspected, as it utilises the TL signal generated by highly radioactive zircon inclusions that exists in some ceramics (Craddock 2009: 113).

The comparison between stylistic criteria and TL showed that of the 101 objects in the Saint Louis collection believed to be ancient, only five were found to be forgeries, but 14 of 16 suspect pieces also proved to be ancient, leading Shaplin to conclude that the visual criteria for identifying fakes needed to be revised (Shaplin and Zimmerman 1978: 48-49). Another conclusion of the study was that objects acquired between 1900 and 1930 were more likely to be forgeries (cf. Craddock 2009: 119, and see Chapter 4). Other collection-wide studies using TL, in particular Vienna (Feest et al. 1984) and Berlin (Goedicke et al. 1992), as well as the published results of specific objects from nineteenth-century collections (Ramírez Luna, Shaaf and Filloy 2001) corroborate this finding and have allowed us to further pinpoint the time when most fakes were being generated.

Sample treatment. I treated half of each sample with hydrogen peroxide (H_2O_2) and chloric acid (HCI) to eliminate organic material and carbonates, and this half of the sample was then used for the TL test using the fine grain method describe by Zimmerman (1971). Grains between 4 µ and 11 µ were selected to determine the paleodose.

Thermoluminescence measurements. Using a Daybreak 110 Automated TL System reader, I took measurements under the following conditions: high vacuum (23 mm Hg), nitrogen atmosphere of high purity (99.99% N_2), heating index of 10°C/s, maximum temperature 500°C (Figure 3).

Paleodose: I estimated the paleodose using the additive method. The additive method consists of irradiating natural samples with different dosages of artificial radiation (NTL+b) that are later observed in the reader machine along with the samples from the natural TL signal (NTL). The intensity of the TL signal versus dosage generates a linear equation. The value of the paleodosage is found by extrapolating the linear equation with the X-axis that corresponds to the dosage. The irradiations were made with a beta particle (β) source of strontium (^{90}Sr) with an activity of 100 mCi (Figure 4).

Annual dose rate. With the other half of each sample, I determined the annual dose of uranium (^{238}U), thorium (^{232}Th), and potassium (^{40}K). The concentration of uranium and thorium was measured by counting kiloseconds (C/ks) in an alpha particle (α) counter (Figure 5). I measured the concentration of potassium by flame photometry (Geology Institute, UNAM) of a sample previously cleaned with hydrofluoric and hydrochloric acids (Figure 6). An average cosmic dose rate of 0.15 mGy/year was used to calculate the concentrations of the radioisotopes alpha, beta, and gamma.

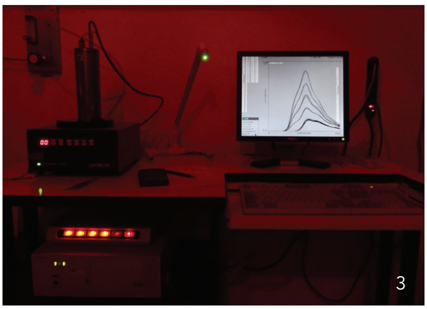



Figure 3: TL reading machine.

Figure 4: Irradiator.

Figure 5: Alpha particle counter.

Figure 6: Submerging samples in acid to determine potassium.

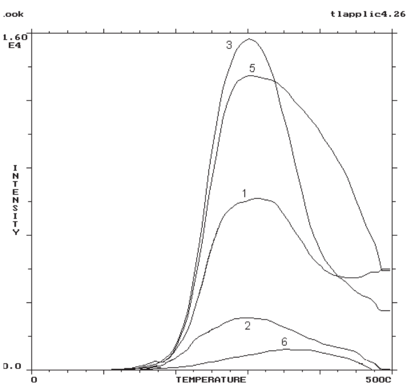
Results

As discussed, the TL method calculates how much time has passed since the last heating event—the moment the potter fired the clay and transformed it into ceramic material. The TL signal from that moment is stored in the ceramic sample until it is heated in the laboratory, emitting luminescent energy that is measured using the following equation:

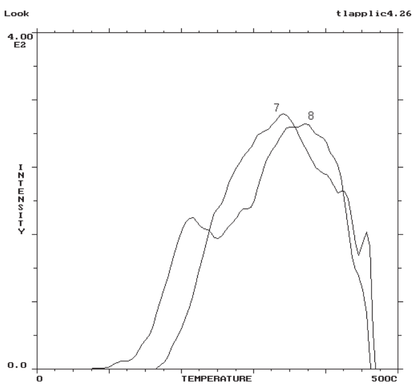
$$Age = \frac{Paleodose\ [Gy]}{Annual\ dose\ rate\ \left[\frac{Gy}{year}\right]}$$

Figures 7a and 7b show the natural TL spectra of each sample taken from HM 1953. In the figures, one can observe well-defined TL peaks at different temperatures in all the samples, although with different intensities. Sample TOR3, for example, shows a luminescent intensity of 15800 u.a., while sample TOR8 shows a luminescent intensity of 310 u.a, The difference in thermoluminescence indicates a difference between the samples in the sensibility of radiations.

Figure 8 uses TOR2 as an example of the spectral analysis procedure followed for all samples. As the sample was heated, light emission was measured. In the case of TOR2, the natural thermoluminescent signal (NTL) showed a well-defined peak around 310°C (Figure 8), and the intensity at the peak (2600 u.a.) indicates the accumulated dosage of the sample. Other samples have different peaks that correspond to different relative ages.



7a

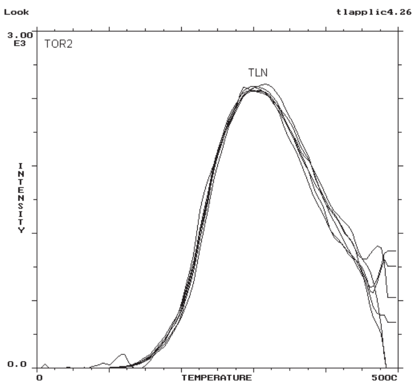


7b

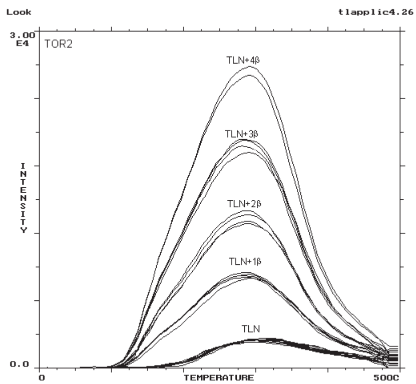
Figure 7a: Natural thermoluminiescent signal of the samples TOR 1, 2, 3, 5 and 6.

Figure 7b: Natural thermoluminiescent signal of the samples TOR 7 and 8.

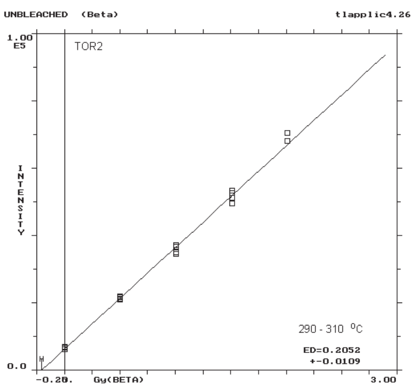
Figure 9 shows the additive method where a natural thermoluminescent signal is paired with a dosage of artificial radiation (NTL+b). When this paired signal matches the natural signal as seen in this figure, then the shared peak indicates that the spectrum is reproducible. In Figure 10, we can see the extrapolation of the linear equation for the calculation of the paleodose. Once the value of the paleodosage and the annual dose rate have been calculated, these values are substituted in the age equation (Age = Paleodose/Annual dose rate). Table 8.1 lists these values with the calculated ages for each sample from urn HM 1953.



8



9



10

Figure 8: Natural thermoluminiescent signal (TLN).

Figure 9: Additive method, TLN+dosage of artificial radiation (β).

Figure 10: Extrapolation in the lineal equation of the additive method for calculating the paleodose.

SAMPLE CODE	AREA SAMPLED	PALEODOSE [GY]	ANNUAL DOSE RATE [GY/YEAR]	ABSOLUTE TL AGE [YEARS]	RELATIVE AGE [YEARS D.C.]
TOR1	Added element top headdress	1.6830	3.080×10^{-3}	546 ± 48	1470 ± 48
TOR2	Right flange on headdress	0.2052	2.643×10^{-3}	77 ± 4	1939 ± 4
TOR3	Base of urn	3.9806	6.033×10^{-3}	659 ± 15	1357 ± 15
TOR4[1]	Base of right foot	--------	6.040×10^{-3}	--------	--------
TOR5	Right arm	3.8416	5.183×10^{-3}	741 ± 17	1275 ± 17
TOR6	Left arm	1.5098	2.116×10^{-3}	713 ± 28	1303 ± 28
TOR7	Left shoulder below cape	0.1978	2.726×10^{-3}	72 ± 4	1944 ± 4
TOR8	Under nose	0.5912	2.312×10^{-3}	255 ± 8	1761 ± 8

Table 1: TL Results for HM 1953.

Discussion

As a museum object with no exact provenance, HM 1953 cannot be precisely dated using thermoluminescence. This is particularity true in this case because the urn had been previously irradiated with X-rays, causing more excited electrons to be trapped in the fabric of the vessel. The real age for each sample is therefore less than the age calculated in our TL analysis. Nonetheless, our work still provides a relative date for the analyzed samples, as well as insights on the composite nature of the object.

In terms of composition, the natural TL spectra of the samples from HM 1953 support the argument from visual inspection that the urn is composed of parts made from different materials. The TL analysis suggests that the molecular structure of the minerals is not uniform throughout the urn. These structural differences, when combined with the varied concentrations of the radioisotopes uranium (^{238}U), thorium (^{232}Th), and potassium (^{40}K), provide further evidence that HM 1953 is a composite piece made from material with different chemical compositions.

Although a precise date cannot be given, we can say that the base of the urn, and very probably the entire cylinder, is of pre-Hispanic manufacture. The bird-wing element that was pasted to the top of the headdress, but is now

a separate piece, resulted in a date that corresponds to pre-Hispanic times, as do the samples from the left and right arms. Our relative dates suggest that the left shoulder and the right flange in the headdress were made in the twentieth century, while the sample taken from under the nose shows an intermediate date but is inconclusive, because the sample may have been contaminated from the presence of other elements that were used to fabricate the nose piece. X-ray fluorescence, discussed in the next chapter, would provide further insights into the chemical differences among the parts assembled to make HM 1953.

Endnotes

1 The sample TOR4 was accidently spilled and it was not possible to carry out the TL test.

References Cited

Aitken, M.J. 1977. "Thermoluminescence and the Archaeologist." *Antiquity* 51: 11–19.

——— 1985. *Thermoluminescence Dating*. London: Academic Press.

Bortolot, Victor J. 1994. "Authentification by Thermolumniescence." *Tribal Arts* 1 (4): 81–83.

Craddock, Paul T., and Bowman S. 1991. "Spotting the fakes," In *Science and the Past*, edited by P. Bowman,141–57. London: British Museum Publications.

Craddock, Paul T. 2009. *Scientific Investigation of Copies, Fakes and Forgeries*. Oxford: Elsevier.

Fleming, Stuart J. 1975 *Authenticity in Art: The Scientific Detection of Forgery*. London: Institute of Physics.

Feest, Ch. F., R. Erlach, B. Pichler, A. Vendl, and N. Vana. 1984. "TL-Untersuchung an südamerikanischen Keramiken 1. Figuralkeramik der Zapoteken." *Wiener Berichte über Naturwissenschaft in der Kunst* 1: 40–42.

Goedicke, Christian, Sabine Henschel, and Ursel Wagner. 1992. "Thermolumineszenzdatierung und Neutronenaktivierungsanalyse von urnengefassen aus Oaxaca." *Baessler-Archiv* 40: 65–86.

Ramírez Luna, Ángel, Peter Schaaf, and Edith Ortiz. 2010. "Analysis of Zapotec Ceramics of the Caxonos River Basin, Oaxaca Mexico by Thermoluminescence (TL)." *Mediterranean Archaeology and Archaeometry* 10 (4): 121–27.

Ramírez Luna, Ángel, Peter Shaaf, and Laura Filloy. 2001. "Prueba de Autenticidad en Cerámica y Figuras Arqueológicas por Termoluminiscencia." Memorias del XII Congreso Nacional Sobre Dosimetría de Estado Sólido, 47–52.

Shaplin, Philippa D., and David Zimmerman. 1978. "Thermoluminescence and Style in the Authentication of Ceramic Sculpture from Oaxaca, Mexico." *Archaeometry* 20 (1): 47–54.

Zimmerman, David. 1971. "Thermoluminescent Dating Using Fine Grains from Pottery." *Archaeometry* 13 (1): 29–52.

CHAPTER 9

X-ray Fluorescence Analysis

AARON SHUGAR / SUNY – BUFFALO STATE, ART CONSERVATION DEPARTMENT

Introduction

Ceramic vessels like HM 1953 can be better understood through an analysis of their chemical composition. By combining their chemical signatures with the results of other technical studies such as petrography, visual examination, imaging techniques, provenance information, and connoisseurship, a stronger case can be made for proper attribution of the artefact.

Investigations of archaeological ceramic chemistries have been of interest for quite some time (Peacock 1970; Bishop, Rands, and Holley 1982; Rice 1987, 1996; Tite 1999). The desired result from these extensive analyses is to establish the chemical composition of an artefact, characterize the ceramics on either a macro or micro level, and source the clay bodies used in ceramic manufacture. Information collected can reveal details concerning the manufacturing process of artefacts, and can also be used to understand issues associated with social and cultural activities in the past, for example, issues related to specialization in manufacturing and social control of an industry (Arnold, Neff, and Bishop 1991; Aimers 2003; Schortman and Urban 2004; Aimers 2010; Urban et al. 2013). Chemical analysis can also be used to determine if an artefact should be classified as a fake, forgery, or pastiche (Craddock 2009).

The range of instrumental analytical techniques used for the investigation of ceramics is vast and includes polarized light microscopy (PLM) (Day et al. 1999; Tite 1999), inductive coupled plasma mass spectroscopy (ICP-MS) (Fermo et al. 2008; Dussubieux et al. 2009; Mannino and Orecchio 2011), neutron activation analysis (NAA) (Glascock 1992; Day et al. 1999; Neff 2002; Speakman et al. 2011), atomic absorption spectroscopy (AAS), scanning electron microscopy (SEM) (Tite, Freestone, and Bimson 1984; Palanivel and Meyvel 2010), and X-ray fluorescence (XRF) (Olin and Blackman 1989; Papadopoulou et al. 2007; Forster et al. 2011; Speakman et al. 2011). However, these analytical techniques tend to be invasive and typically require a sample taken from the

artefact. Handheld X-ray fluorescence (XRF) coincides with the recent trend for non-destructive, non-invasive analysis of archaeological and art artefacts and allows scientists to investigate artefacts without causing damage.

Handheld X-ray fluorescence spectrometry has a long history and was first developed for the mining and scrap metal markets in the early 1960s (Piorek 1997). Its use in the fields of art and archaeology did not begin until the mid-2000s, when miniaturization of the technology made the apparatus more affordable. Today, handheld XRF is widely used to investigate archaeological materials ranging from metals and ceramics to bone and textiles, to name but a few (see X-ray Fluorescence Spectroscopy).

X-RAY FLUORESCENCE SPECTROSCOPY (XRF)

XRF is an analytical technique that provides information as to the elemental composition of materials. It is a non-destructive and non-invasive. It employs a focused X-ray photon beam that interacts with atoms in the sample causing them, in turn, to create characteristic photons with specific energies for each element in the periodic table. The resulting photons can then be captured by a detector and compiled to provide a spectral fingerprint of the collective atoms in the sample. This technique can be used to accurately quantify the constituents of whatever is being examined, provided sample specific calibrations are performed. XRF is used extensively in the scrap metal industry to help sort different compositional metals from one another. Within art and archaeology, XRF is widely used to help identify various artist's pigments, characterize metal artefacts (sculpture and archaeological metals), identify heavy metal pesticides, and characterize photographic processes to name a few applications.

As stated above, research of archaeological ceramics has focused on acquiring quantitative elemental data in order to source the materials used in their manufacture. The invasive techniques mentioned above all provide quantitative data with a high degree of precision and the ability to measure very low concentrations (in some cases as low as parts per billion), and numerous publications have demonstrated the potential of these instruments for sourcing ceramics (Olin and Blackman 1989; Adan-Bayewitz, Asaro, and Giauque 1999; Speakman et al. 2011; Quinn 2013; Minc, Sherman, and Pink 2015; Tamilarasu et al. 2015). When performing quantitative analysis of ceramics using handheld XRF, several issues arise: the technique is surface sensitive and results can be highly variable when there are surface alterations; while ceramics are heterogeneous by nature, some have temper (inclusions) of various sizes, as well as surface alterations or coatings (i.e., slips, pigmentation, burial accretions) that can affect surface chemistries (Shugar 2013); sample porosity and particle inclusion can greatly affect the quantification of some elements of interest. Thus, with handheld XRF it is more difficult to obtain reliable quantitative data from ceramics non-destructively. Of course, when samples are taken (drilled out of the body, or a section crushed into powder) calibration of handheld XRF can be performed with relative ease (Speakman et al. 2011; Aimers, Farthing, and Shugar 2012; Hunt and Speakman 2015).

Because of these limitations, it is sometimes best to rely on qualitative data rather than quantitative data for comparison (Shugar 2009; Shugar and Mass 2012; Shugar 2013). Qualitative data will not provide specific concentrations of each element in a ceramic body, but will relay clear differences in general composition or compositional trends. This is based on the physics behind XRF, which produces higher peaks for elements that have greater concentrations. One can still compare samples by looking for peak-height variation in the elements of interest to see if there are differences. Most ceramics artefacts are built from the same clay sources, so if samples show variation in their peak intensities, one can surmise that the pieces analyzed come from different clay sources. Therefore, the artefact could be a pastiche constructed from various pieces of the same period, of a later but still ancient period; or of more modern materials. Yet the mixed use of clays on the same artefact does not always imply deception. On occasion, potters will use clay blends from different sources to enhance the physical properties and workability of the material (Day et al. 1999). So, for example, a potter might use the coarse mix of a mechanically strong clay body to construct the structural components of the artefact, and a finer clay body to create the decorative aspects.

Methodology

Handheld XRF analysis was performed *in situ* on Zapotec effigy vessel HM 1953, focusing in on several locations thought to be original to the artefact and those that may have been added at a later time. X-ray fluorescence spectra

were collected using a Bruker Tracer III-SD handheld energy-dispersive X-ray spectrometer. The excitation source was a rhodium (Rh) target X-ray tube, operated at 40 kV and 30 µA current. A yellow filter (12 mil Aluminum, 1 mil Titanium, where 1 mil = 25.4 µm) was used to reduce the background radiation and enhance the sensitivity in the energy range of interest. The X-ray beam interacted with the sample over an area the shape of an oval (with axes 4 mm and 5 mm), making this analysis a bulk measurement. X-ray signals were detected using a Peltier-cooled XFlash silicon drift detector (SDD) with a resolution of 146.4 eV. Spectral interpretation was performed using the Bruker ARTAX Control software. Spectra were collected over 60 seconds live time.

Sample regions were selected in consultation with object conservator Laura Lipcsei. The idea was to investigate several areas that might have been manufactured using different ceramic bodies. Qualitatively, the chemical signature specific to each unique material type would be clearly identifiable using handheld XRF. Handheld XRF can detect and identify elements from magnesium (Mg) to uranium (U). For each element, a graph depicts the element's characteristic photon energy (on the x-axis) by the intensity of those photons (on the y-axis) (Figure 1).

Seventeen locations on the urn were tested, with two areas tested twice to ensure consistency (Figure 2, Table 1). These analyses covered a range of areas thought to potentially consist of different types of ceramic bodies.

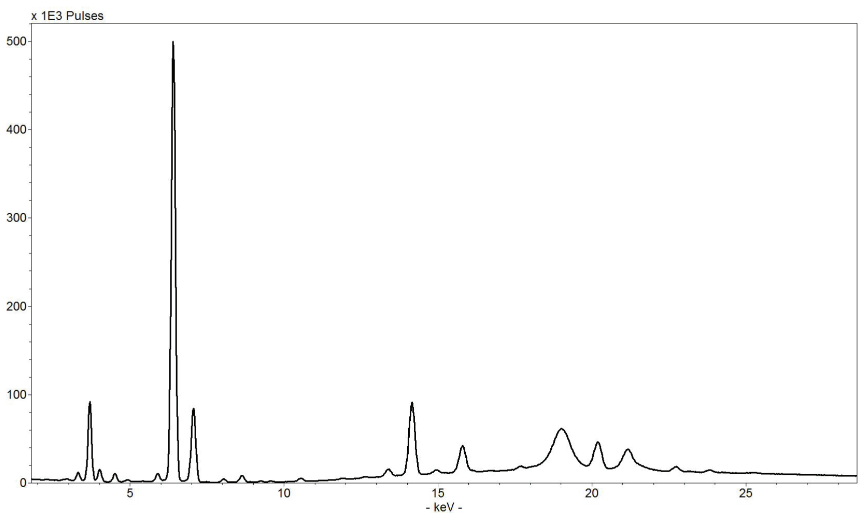


Figure 1: Typical XRF spectrum with photon energy on the x-axis and intensity on the y-axis. Peaks are indicative of specific elements and their relative height is related to their concentration in the sample.

Figure 2: Zapotec effigy vessel HM 1953: Spots and numbers indicate locations of XRF analysis.

1. Detached Ear	10. Cylinder
2. Detached fragment	11. Proper left arm
3. Right proper arm*	12. Proper left shoulder*
4. Central plaque	13. Proper right shoulder
5. Chest over heart	14. Base outer cylinder**
6. Head dress ridge over left eye	15. Base inner cylinder**
7. Broken nose	16. Base proper left bottom leg**
8. Unbroken nose	17. Base proper right bottom leg**
9. Proper left side leg	* Indicates two analyses
	** Sample locations are not seen

Table 1: XRF sample location.

Results and Discussion

Twenty-one elements were detected in the Zapotec effigy vessel, in major, minor, and trace concentrations (Table 2). Several of these elements can be used to diagnostically compare the ceramics. In particular, the minor and trace elements rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), and niobium (Nb) have been used for sourcing ceramic materials with some success. Although it would seem natural to start by making comparisons of the major elements, silicon (Si) and iron (Fe), these are so ubiquitous in the Earth's upper crust that there is typically not much variation in their concentrations when a similar clay is used (i.e., earthenware terracotta clay with a high iron content has a red colour vs. ball clay mainly composed of kaolinite that has a low iron content and a white colour) as is the case here, but they can be compared to minor and trace elements to clarify differences observed in other analyses. In addition, slight variations in the collection of the characteristic

ELEMENT	MAJOR, MINOR OR TRACE
Silicon (Si)	Major
Calcium (Ca)	Major
Iron (Fe)	Major
Aluminum (Al)	Minor
Potassium (K)	Minor
Robidium (Rb)	Minor
Strontium (Sr)	Minor
Zirconium (Zr)	Minor
Sulfur (S)	Trace
Titanium (Ti)	Trace
Chromium (Cr)	Trace
Manganese (Mn)	Trace
Copper (Cu)	Trace
Zinc (Zn)	Trace
Gallium (Ga)	Trace
Lead (Pb)	Trace
Bromine (Br)	Trace
Yttrium (Y)	Trace
Niobium (Nb)	Trace
Tin (Sn)	Trace
Barium (Ba)	Trace

Table 2: Elements detected by handheld XRF and an indication of their relative concentration in Major, Minor and Trace amounts.

photons emitted by the sample can change the total intensity recorded. The best way to overcome these instrumental variables is to ratio certain elements to one another to see if there are clear differences. For that reason rubidium, strontium, and yttrium were chosen for initial comparison, and then iron was added in to clarify a potential variation in the data.

Issues related to surface alterations (as mentioned above) can be partially mitigated when looking at elements with a higher atomic number. This is because elements with higher atomic numbers have higher characteristic X-ray photon energy, and as such, those photons can escape from a larger depth within the sample. Elements with lower atomic numbers, like silicon, have a much smaller escape potential (Table 3). Elements of higher atomic number are therefore less affected by alterations in surface effects.

When you plot Y/Rb by Sr/Rb, two clear and distinct groupings appear (Figure 3). The tight nature of the groupings suggests that two separate clay body sources were used, one for each distinct set. From these two clear groupings a single point, circled in green, does not fall as tightly as the other points and might indicate a separate grouping altogether. To clarify this, ratios of Rb/Fe were plotted against Sr/Rb. These results (Figure 4) indicate that the questionable point in Figure 3 does indeed belong in a separate grouping. Thus, there are three distinct compositional groupings associated with this object. The specific locations that belong to each group are listed in Table 4. Based on the analysis, as well as visual examination and connoisseurship, group 1 appears to be from the original and groups 2 and 3 are additions.

ELEMENT	PHOTON ESCAPE DEPTH	UNIT
Si	24	μm
Ca	70	μm
Fe	271	μm
Rb	0.19	cm
Sr	0.27	cm
Y	0.3	cm
Zr	0.38	cm

Table 3: Approximate photon escape potential for several elements of interest (based on a density of 2.3 g/cm^3). Note that the higher atomic number elements have the potential to escape from a much larger volume of ceramic.

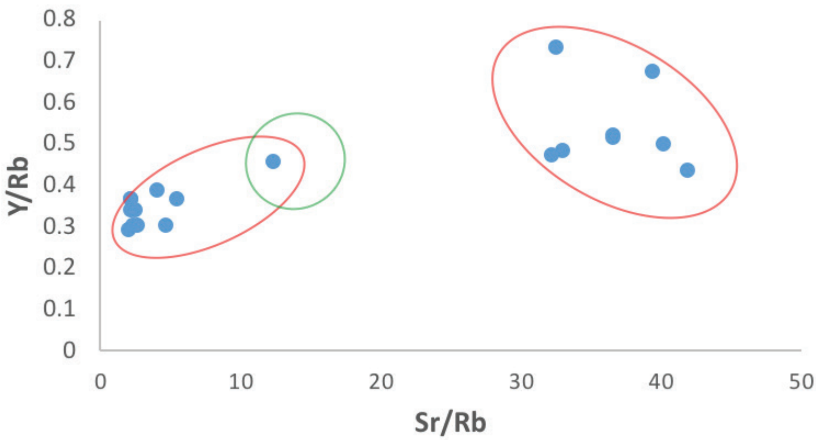


Figure 3: Plot of Y/Rb and Sr/Rb derived from the XRF analysis HM 1953. The data plots into two distinct groups and a possible third.

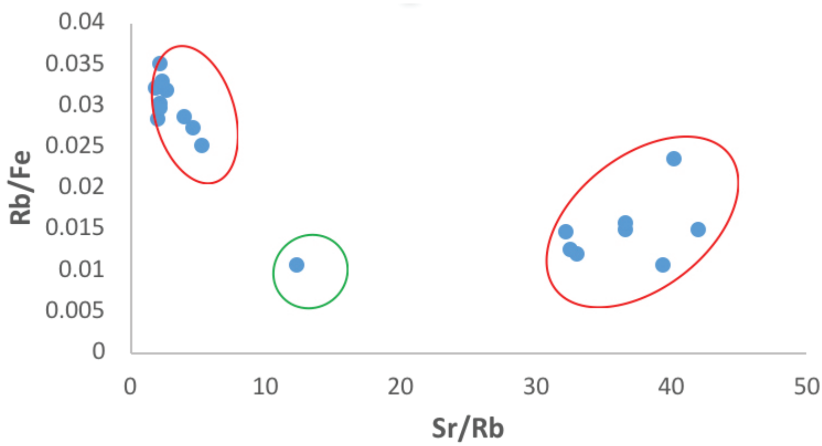


Figure 4: Plot of Rb/Fe and Sr/Rb derived from the XRF analysis HM 1953. The data plots into three distinct groups.

SPOT	DESCRIPTION	GROUPING
3	Right proper arm*	1
5	Chest over heart	1
6	Head dress ridge over left eye	1
9	Proper left side leg	1
10	Cylinder	1
14	Base outer cylinder	1
15	Base inner cylinder	1
16	Base proper left bottom leg	1
17	Base proper right bottom leg	1
1	Detached Ear	2
4	Central plaque	2
7	Broken nose	2
8	Unbroken nose	2
11	Proper left arm	2
12	Proper left shoulder*	2
13	Proper right shoulder	2
2	Detached fragment	3

Table 4: Grouping locations from XRF analysis of the Figurine HM 1953.
* These analyses were made at the location.

As stated earlier, there are three possible reasons for these distinct groups. First, they may be related to the specific functionality of the effigy vessel, with structural components and decorative components comprised of different ceramic bodies. However, this is unlikely given that both structural and decorative components comprise groups 1 and 2 while group 3, the detached decorative fragment, is an isolated group. Second, the fairly tight clustering of data points for the two groups could indicate a pastiche—an artefact constructed of fragments from several other similar objects in order to manufacture a more complete one, a practice seen in ceramic vessels from other geographic locations and cultural groups (La Duc 2012). The intermediate plot would suggest that a fragment from a third artefact was added as well. Third, someone may have fabricated the components in group 2 to complete the effigy for sale sometime in the modern era, a possibility supported by the chemistry and the tight plots of group 2. If that is the case, the object in group 3 might be an ancient fragment, as there is no reason for a potter to use a different clay for one isolated decorative element.

Summary and Conclusions

Handheld XRF was used to qualitatively assess the chemical composition of Zapotec effigy vessel HM 1953. The results of the analysis indicate three

distinct groups of chemistries. Although a potter might, in practice, use different clays for different functional purposes when constructing an artefact, the results suggest that this object is more likely a pastiche with ancient and more contemporary parts added to an ancient core. As seen in this volume, a more definitive conclusion can be obtained when XRF data is combined with the results of petrography, various imaging technologies, visual examination, and connoisseurship.

References Cited

Adan-Bayewitz, D., F. Asaro, and R. D. Giauque. 1999. "Determining Pottery Provenance: Application of a New High-Precision X-ray Fluorescence Method and Comparison with Instrumental Neutron Activation Analysis." *Archaeometry* 41 (1):1–24.

Aimers, James J. 2003. "Abandonment and Nonabandonment at Baking Pot, Belize." In *The Archaeology of Settlement Abandonment in Middle America*, edited by Takeshi Inomata and Ronald W. Webb, 149–62. Salt Lake City: University of Utah Press.

———. 2010. "You Only Live Twice: The Agency of Ritual Ceramics at Lamanai." *Research Reports in Belizean Archaeology* 7: 119–25.

Aimers, Jim J., Dori J. Farthing, and Aaron N. Shugar. 2012. "Handheld XRF Analysis of Maya Ceramics: A Pilot Study Presenting Issues related to Quantification and Calibration." In *Handheld XRF for Art and Archaeology*, edited by Aaron N. Shugar and Jennifer L. Mass, 423–48. Leuven: Leuven University Press.

Arnold, D. E., H. Neff, and R. L. Bishop. 1991. "Compositional Analysis and 'Sources' of Pottery: An Ethnoarcheological Approach." *American Anthropologist* 93 (1): 70–90.

Bishop, Ronald L., Robert L. Rands, and George R. Holley. 1982. "Ceramic Compositional Analysis in Archaeological Perspective." *Advances in Archaeological Method and Theory* 5: 275–330.

Craddock, P. T. 2009. *Scientific Investigation of Copies, Fakes and Forgeries*. 1st ed. Oxford: Butterworth-Heinemann.

Day, Peter M., Evangelia Kiriatzi, Alexandra Tsolakidou, and Vassilis Kilikoglou. 1999. "Group Therapy in Crete: A Comparison Between Analyses by NAA and Thin Section Petrography of Early Minoan Pottery." *Journal of Archaeological Science* 26 (8): 1025–36.

Dussubieux, Laure, Richard Cox, Mark Golitko, and Patrick Ryan Williams. 2009. "ICP-MS with Adaptable Chamber Laser: Quantitative Analysis of Glass, Metal and Ceramic Artefacts in the Museum Environment." Paper presented at the FACSS 2009, at Louisville, KY.

Fermo, Paola, Eleonora Delnevo, Marina Lasagni, Silvia Polla, and Mariette de Vos. 2008. "Application of Chemical and Chemometric Analytical Techniques to the Study of Ancient Ceramics from Dougga (Tunisia)." *Microchemical Journal* 88 (2): 150–9.

Forster, N., P. Grave, N. Vickery, and L. Kealhofer. 2011. "Non-destructive Analysis using PXRF: Methodology and Application to Archaeological Ceramics." *X-Ray Spectrometry* 40: 389–98.

Glascock, Michael D. 1992. "Characterization of Archaeological Ceramics at MURR by Neutron Activation Analysis and Multivariate Statistics." In *Chemical Characterization of Ceramic Pastes in Archaeology*, edited by Hector Neff, 11–26. Madison, WI: Prehistory Press.

Hunt, Alice M. W., and Robert J. Speakman. 2015. "Portable XRF Analysis of Archaeological Sediments and Ceramics." *Journal of Archaeological Science* 53: 626–38.

La Duc, Elizabeth. 2012. *The Analysis and Conservation of a Group of Islamic Ceramics from the Buffalo Museum of Science*. Department of Art, Conservation, State University College at Buffalo.

Mannino, Maria Rosaria, and Santino Orecchio. 2011. "Chemical Characterization of Ancient Potteries from Himera and Pestavecchia Necropolis (Sicily, Italy) by Inductively Coupled Plasma–Optical Emission Spectrometry (ICP–OES)." *Microchemical Journal* 97 (2): 165–72.

Minc, Leah, Jason Sherman, and Jeremias Pink. 2015. "Trace-element and Mineralogical Analysis of Field Clays, Valley of Oaxaca, Mexico, as a Basis for Archaeological Ceramic Provenance Determination." Oregon State University Libraries & Press. Dataset. http://dx.doi.org/10.7267/N9MS3QN0

Neff, Hector. 2002. "Quantitative Techniques for Analyzing Ceramic Compositional Data." In *Ceramic Production and Circulation in the Greater Southwest: Source Determination by INAA and Complementary Mineralogical Investigations*, edited by D. M. Glowacki and H. Neff, 15–36. Monograph 44. Los Angeles: The Cotsen Institute of Archaeology at UCLA.

Olin, Jaqueline S., and M. J Blackman. 1989. "Compositional Classification of Mexican Majolica Ceramics of the Spanish Colonal Period." In *Archaeological Chemistry IV*, edited by Ralph O. Allen, 87–112. Washington DC: American Chemical Society.

Palanivel, R., and S. Meyvel. 2010. "Microstructural and Microanalytical Study (SEM) of Archaeological Pottery Artefacts." *Romanian Journal of Physics* 55 (3–4): 331–41.

Papadopoulou, D., A. Sakalis, N. Merousis, and N. C. Tsirliganis. 2007. "Study of Decorated Archeological Ceramics by Micro X-ray Fluorescence Spectroscopy." *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* 580 (1): 743–46.

Peacock, D. P. S. 1970. "The scientific analysis of ancient ceramics: A review." *World Archaeology* 1 (3): 375–89.

Piorek, Stanislaw. 1997. "Field-portable X-ray Fluorescence Spectrometry: Past, Present, and Future." *Field Analytical Chemistry & Technology* 1 (6): 317–29.

Quinn, Patrick Sean. 2013. *Ceramic Petrography: The Interpretation of Archaeological Pottery & Related Artefacts in Thin Section*. Oxford: Archaeopress.

Rice, Prudence M. 1987. *Pottery Analysis: A Sourcebook*. Chicago: University of Chicago Press.

———. 1996. "Recent Ceramic Analysis 2: Composition, Production, and Theory." *Journal of Archaeological Research* 4 (3):165–202.

Schortman, Edward M., and Patricia A. Urban. 2004. "Modeling the Roles of Craft Production in Ancient Political Economies." *Journal of Archaeological Research* 12 (2): 185–226.

Shugar, Aaron N. 2009. "Peaking Your Interest: An Introductory Explanation of How to Interpret XRF data." *Western Association for Art Conservation*

Newsletter 31 (3): 8–10.

———. 2013. “Portable X-ray Fluorescence and Archaeology: Limitations of the Instrument and Suggested Methods to Achieve Desired Results.” *Archaeological chemistry VIII. American Chemical Society, Washington DC*: 173–93.

Shugar, Aaron N., and Jennifer L. Mass, eds. 2012. *Handheld XRF for Art and Archaeology*. Leuven: Leuven University Press.

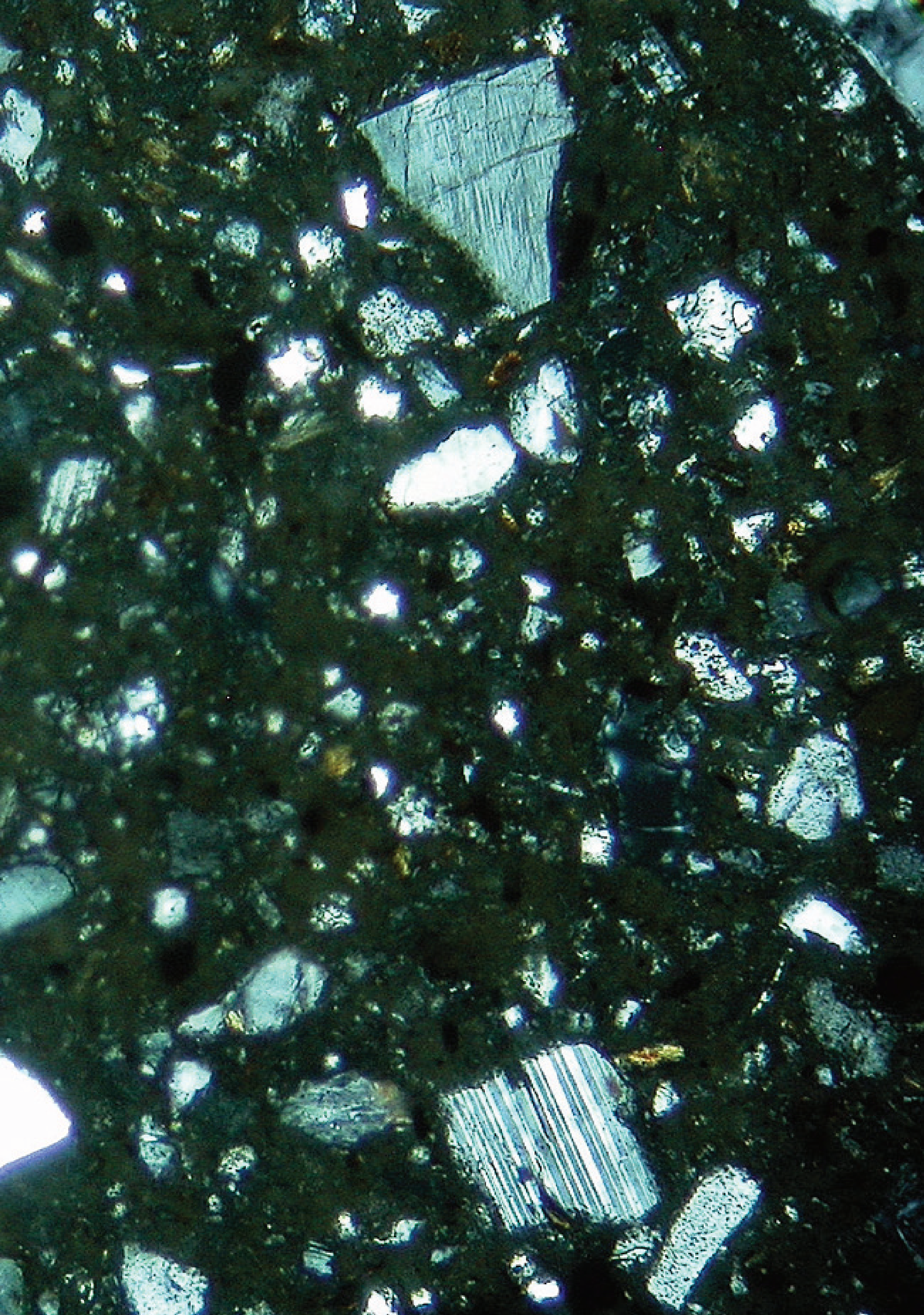
Speakman, Robert J., Nicole C. Little, Darrell Creel, Myles R. Miller, and Javier G. Iñañez. 2011. “Sourcing Ceramics with Portable XRF Spectrometers? A Comparison with INAA using Mimbres Pottery from the American Southwest.” *Journal of Archaeological Science* 38: 3483–96.

Tamilarasu, S., K. K. Swain, R. K. Singhal, A. V. R. Reddy, R. Acharya, and G. Velraj. 2015. “Analyses of Archaeological Pottery Samples using X-ray Fluorescence Technique for Provenance Study.” Paper presented at the Proceedings of the BRNS-AEACI first symposium on current trends in analytical chemistry: book of abstracts.

Tite, M. S. 1999. “Pottery Production, Distribution, and Consumption: The Contribution of the Physical Sciences.” *Journal of Archaeological Method and Theory* 6 (3): 181–233.

Tite, M. S., I. C. Freestone, and M. Bimson. 1984. “A Technological Study of Chinese Porcelain of the Yuan dynasty.” *Archaeometry* 26 (2): 139–54.

Urban, P. A., Aaron N. Shugar, Laura Richardson, and Edward Schortman. 2013. “The Production of Copper at El Coyote, Honduras: Processing, Dating, and Political Economy.” In *Archaeometallurgy in Mesoamerica: Current Approaches and New Perspectives*, edited by A. Shugar and S. Simmons, 77–112. University Press of Colorado.



CHAPTER 10

Petrographic Analysis

KAY SUNAHARA / ROYAL ONTARIO MUSEUM
ROBERT MASON / ROYAL ONTARIO MUSEUM

Petrographic analysis is a technique borrowed from geology and optical mineralogy. First used in the service of archaeology by Anna O. Shepard (1939, 1956) and David P. S. Peacock (1970, 1968) from the 1950s through the late 1960s, petrography enables us to define the mineralogical makeup of a ceramic sample. This is done by identifying, describing, and quantifying the small rocks and minerals (inclusions) incorporated into the clay of a vessel. The result of the analysis is the description of a "petrofabric" (Mason 1991) that can be easily compared to other petrofabrics. Mineralogy combined with granulometry (analysis of the shape, size, and distribution of inclusions) can help us identify geological origins and production centres, as well as determine the area over which ceramics were traded and distributed.

To analyze Zapotec urn HM 1953, we took samples from different parts of the vessel. As the object was deconstructed by ROM ceramics conservator Laura Lipcsei, two samples were extracted from parts that were thought to belong to the original object, using a Dremel tool in the conservation lab. We took other samples from the parts that Lipcsei had separated from the original object. These detached parts were sampled in the ROM Ceramic Petrology Laboratory on a Buehler IsoMet 1000 Precision Cutter. Aside from working with Lipcsei to extract the initial samples, the thin-sectioning and petrographic analyses were done in relative isolation so that the conclusions drawn from our findings could be considered independent and relatively free of influence from our colleagues' research teams. Using ceramic petrography we were able to see if our samples from the urn were made using clays derived from similar or different geological areas, having comparable or dissimilar petrofabrics.

Ceramic petrography involves producing standard geological thin-sections from selected pottery samples and analyzing the thin-sections under a polarizing

light microscope. Pottery vessels will reflect the geological composition of the material, clay, and temper that were used to produce them (Day et al. 1999; Mason 2003: 271–72; Middleton et al. 1985). The results may also indicate the type of workshop in which the vessels were made. Specialized pottery-production workshops are thought to have created similar vessel forms with similar inclusion patterns, or to have used recipes that reflected specialized craft-production activities (Middleton et al. 1985). On the other hand, household-level production is thought to be reflected in more variable, less standardized petrofabrics.

Background: Geology of the Oaxaca Valley

The Valley of Oaxaca is comprised of the Zimatlán–Ocotlán arm to the south, the Etla arm to the northwest, and the Tlacolula–Mitla arm to the east (Figure 1). Drainage flows southward from the Etla arm through the Zimatlán–Ocotlán arm by the Río Atoyac; and westward from the Tlacolula-Mitla arm by the Río Salado, which joins the Río Atoyac south of Oaxaca City. The mountains to the west are dominated by Precambrian meta-granitic rocks and gneiss; east of the Etla arm is the Sierra de Juárez mylonitic complex that metamorphosed in the Late Permian–Middle Jurassic period; in the central highlands and north and south of the Tlacolula–Mitla arm are Cretaceous sedimentary rocks (limestones and sandstones); while Tertiary volcanics of rhyolitic and andesitic chemistry are found east of the Zimatlán–Ocotlán arm and north of the Tlacolula-Mitla arm (Alaniz-Alvarez et al. 1994).

Methodology: Petrographic Analysis

Petrographic analysis entails cutting off a sample and then grinding and polishing one side optically flat. This flat surface is then fixed to a glass slide and the rest of the sample is cut off and ground down so that what remains on the slide is a section 0.03 mm thick. This is called a thin-section, and it is thin enough that most materials in the sample are transparent (with the exception of metals, most metal oxides, sulphides, and some other minerals collectively known as "opaques"). The thin-section is then observed through a petrographic microscope fitted with a number of optical aids, including polarizing filters. These aids help us identify the rocks and minerals in the sample. We can also make observations on the texture and relationships of the rocks and minerals, the degree of roundness or angularity of the grains, the degree of sorting, and the variation in grain sizes.

This technique works with pottery because the ceramic body contains rocks and minerals, known as inclusions, and analysis of these inclusions provides the basis for defining the petrofabric of the sampled piece. In the case of clay-based ceramics, the inclusions are known as "aplastics" to differentiate from the "plastic" clay minerals. Aplastics are necessary to reduce shrinking

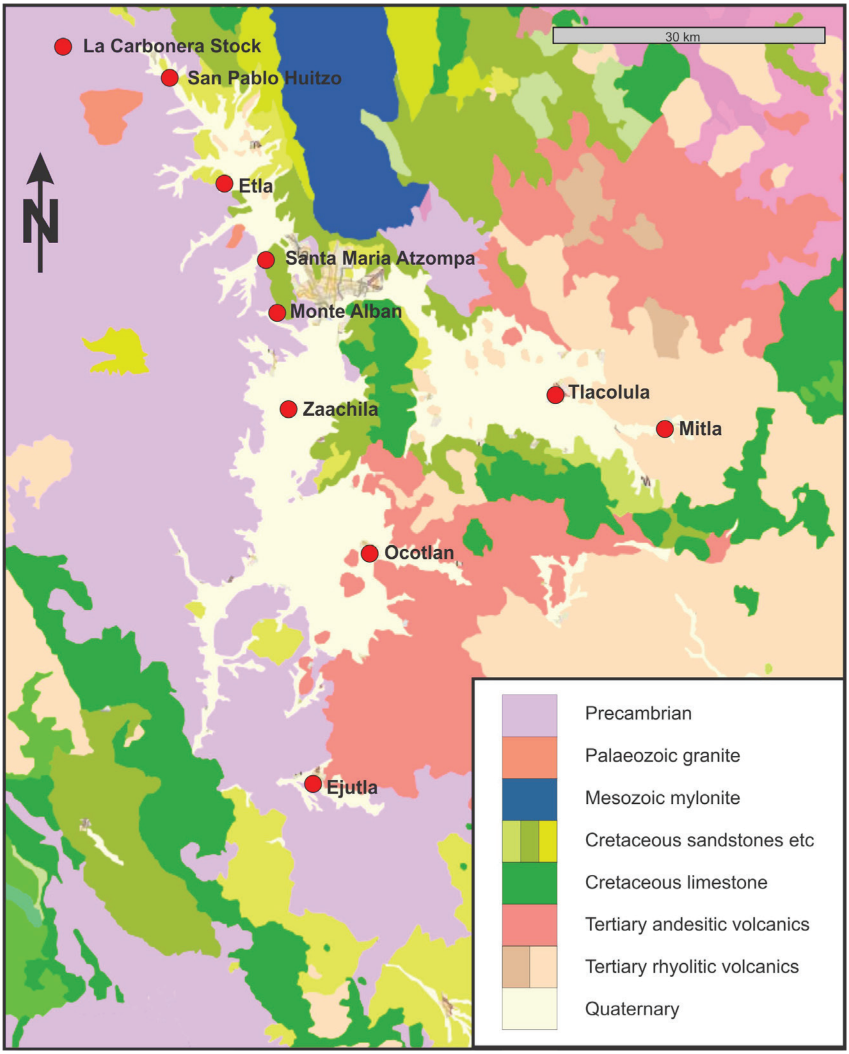


Figure 1: Geological map of the study region after Instituto Nacional de Estadística y Geografía (Digital map of Mexico Version 6.1) and Google Earth.

during drying and firing, and to prevent various other problems that would occur with a ceramic consisting entirely of clay minerals. In some cases the pottery is "tempered," by having aplastics added deliberately by the potter (see Mason and Cooper 1999 for a discussion).

The methodology used in this study is that of the Ceramic Petrology Laboratory of the Royal Ontario Museum, most fully described in Mason (2004) and Sunahara (2009). It is based on practices established by geologists and sedimentologists, with limited adaption for archaeological ceramics. The accompanying sidebars, Petrographic Data: Relative Abundance and Petrographic Data: Granulometry, are an overview of the types of analyses performed and observations that were made on the thin-section samples from urn HM 1953. Relative abundance analyzes quantities of the minerals present, while granulometry includes observations on grain size, shape, sorting, and distribution of those minerals.

PETROGRAPHIC DATA: RELATIVE ABUNDANCE

What is Relative Abundance?

The relative abundance of each mineral or mineral variety is expressed as a total percentage of the body. This value is obtained by comparison with special charts (Terry and Chillingar 1955). This process can be rapid and is also considerably more informative than simple word descriptions such as "abundant," "scarce," and so on, that may have no defined limits. Although effectively subjective, and prone to certain optical effects, it has been found to be sufficiently accurate for this material, and repeated analyses of the same thin-section have produced effectively the same results. For statistically valid samples geologists may take one thousand counts using a point counting method. For ceramics with a lot of clay groundmass there may not be a thousand grains present in an entire thin-section to count, and the wide variation in grain size, often mixed by processing and unsorted by natural process, makes it difficult to calculate the appropriate count interval (Freestone 1991). Use of comparison charts is recognized as being scientifically credible by geologists, who are the arbiters of methodological rigour in this matter.

PETROGRAPHIC DATA: GRANULOMETRY

Describing Shape

A grain freshly broken or weathered from its original rock is commonly angular. As it is transported and weathered it goes through various stages to become rounded. Comparison charts for estimation of roundedness in sedimentology texts (e.g., Pettijohn et al. 1987, figure A-2) are generally aimed at characterizing three-dimensional grains in sediment samples rather than two-dimensional grains in thin-sections. The classification used here begins with angular grains that appear as though freshly broken. Subangular grains show some wear on the sharp edges, but are essentially still angular in general shape. A subrounded grain is largely rounded, but still retains some planar fracture or cleavage planes. Rounded grains are completely rounded, with no planar attributes, but may be embayed. Well-rounded grains have no embayments.

Quantifying Grain size

Descriptions of grain size used in our petrofabric descriptions are based on Folk (1980). Grain or particle size distribution is recorded by counting about 150 grains in a ribbon-shaped sample of the thin-section observed in this study at 100× magnification, and recalculating this to 100%; distribution therefore expresses the proportion of grains of a certain size in relation to the total number of grains, not to the entire body as in the percentage of mineral abundance. This method was developed and tested specifically for use in archaeological ceramics by Andrew Middleton and colleagues at the British Museum (Middleton et al. 1985).

What is Sorting?

A related statistic is degree of sorting of the grains. Although sedimentologists use very closely defined parameters in their definitions, this may be simplistically described as meaning that a “sorted” fabric has grains of more-or-less the same size, while an “unsorted” fabric comprises grains of a diversity of sizes. Actual terms as defined by sedimentologists (very well sorted, well sorted, moderately sorted, and poorly sorted) refer to rigidly defined parameters, but acceptable comparison charts are available (e.g., Pettijohn et al. 1987, figure A-1). However, these are again specific to sandstones that are densely packed with particles. A matrix-dominated version, more useful to archaeological ceramic petrologists, has been developed (Mason 2004, figure 2.6).

Bimodal distribution

Typically a natural assemblage of grains will be unimodal, with one mode - being the most commonly occurring grain size, with gradually less larger and smaller grains. A bimodal distribution does not conform to this pattern, but will have a second mode, another maximum in the grain size distribution. This is usually due to a mixing of two sources of grains. Some ceramic petrographers use this bimodal distribution to suggest that silt or sand has been added to a clay resource, hence creating two populations of grains. Yet, it is possible to find bimodal grain size distributions in nature, and the Oaxaca Valley would provide an excellent opportunity for this with rivers carrying fine sediments, and the mountainous regions around the valley bringing in coarser sediments. However, mixing by potters is known to be practised by the modern potters of Santa Maria Atzompa, and Shepard (1967) considered all coarse grain populations to be "temper."

Petrography of Zapotec Urn HM 1953

Preliminary macroscopic inspection showed little discernable difference between any parts of the object which we observed to be made of fine to medium sand comprising primarily feldspars or white volcanic rock (these being difficult to distinguish). Fragments seem to show variable degrees of oxidization: some have a grey surface but a brown core; others have a black core, brown margins, and grey only at the very exterior; while others are uniformly grey throughout. As there were no fresh surfaces anywhere, and sampling involved sawing through the pottery, we did not record colour with a Munsell chart.

Ten samples were taken from the object using a diamond-impregnated saw blade (as seen in Figure 2) from an ornamental plaque on the loincloth, 2) from the object's right ear flange, 3) from the loincloth, 4) from the object's right arm, 5) from the object's left arm, 6) from the object's left leg, 7) from the left shoulder, 8) from behind the ear, 9) from the loin cloth, and 10) from an ornamental plaque affixed to the headdress of the figure, and thought to have been the original plaque from which moulded copies were made to attach to the apron (Sample 1 is one of these copies). Samples 8 and 9 were from the core object, and were the samples thought to most certainly represent the original object; all the other samples were from parts attached to the core object. Although it would have been desirable, no samples were taken from the cylinder at the centre of the object. Petrographic analysis identified four main petrofabric groups, each named "ZU" (for Zapotec Urn) and numbered 1 through 4.

Figure 2: ROM HM1953 petrography sample locations.

Petrofabric Group One (ZU1). This includes Samples 5 and 6 (Figures 3, 4, and 5). The petrofabric comprises inclusions in a bimodal grain size distribution.

The fine population consists of well-sorted, subangular, coarse to medium silt (average of about 0.03 mm) comprising 20% quartz, 3% deeply sericitized (altered) feldspar, 3% opaques, 1% biotite, and trace muscovite, amphibole, epidote, perthitic feldspar, and clinopyroxene.

The coarse population consists of well-sorted, subangular, medium sand (average of 0.3 mm) comprising 5% granophyric feldspar, 5% felsic volcanic (probably a rhyolite), 2% highly undulose quartz, 2% clear plagioclase with an indistinct extinction, 2% sericitized (altered) untwinned feldspar (orthoclase), and 2% polymineralic (rock) fragments that themselves comprise the same mineralogy as found in this grain population (excluding the felsic volcanic).

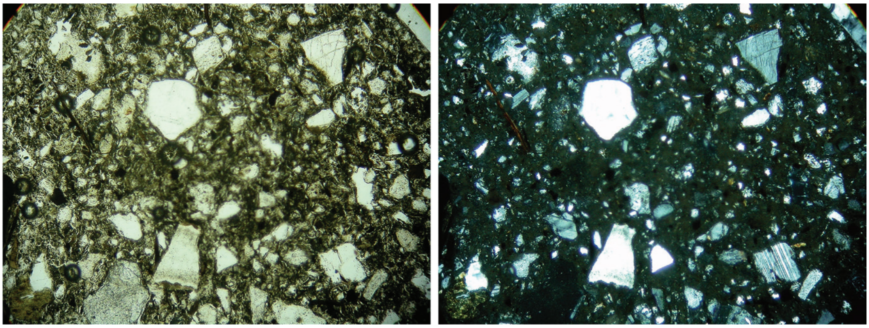


Figure 3: Micrograph, ZU1, Sample #5, plain and cross polarized light, 40X magnification.

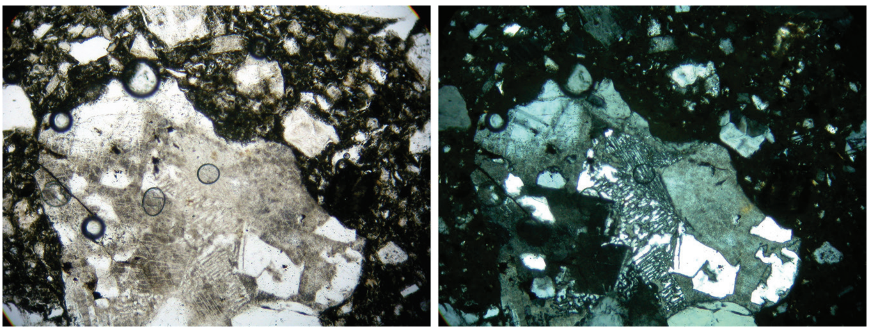


Figure 4: Micrograph, ZU1, Sample #5, granophyric textured feldspar, plain and cross polarized light, 100X magnification.

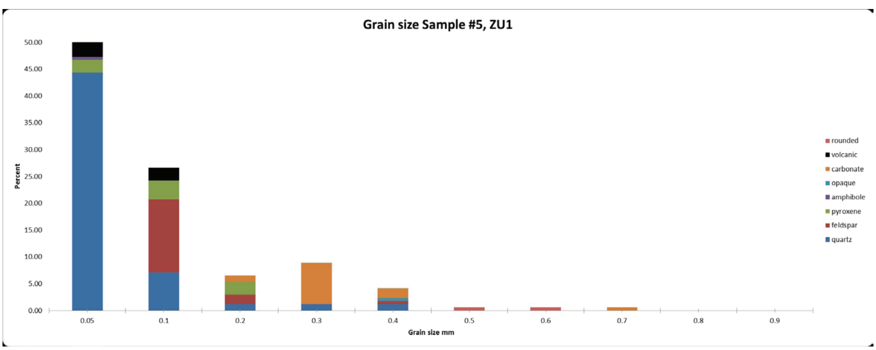


Figure 5: Grain size chart for Sample #5, ZU1.

Petrofabric Group Two (ZU2). This includes Samples 8 and 9 (Figures 6 and 7). The petrofabric comprises inclusions in a bimodal grain size distribution.

The fine population consists of well-sorted, subangular, coarse to medium silt (average of about 0.02 mm) comprising 10% quartz, 1% deeply sericitized (altered) feldspar, 1–2% opaques, and trace biotite, muscovite, amphibole, epidote, perthitic feldspar, and clinopyroxene.

The coarse population consists of well-sorted, subangular, medium sand (average of 0.3 mm) comprising 3% quartz, 2% granophyric feldspar, 2% sericitized (altered) untwinned feldspar (orthoclase), 1% clear plagioclase with an indistinct extinction, 1% felsic volcanic (probably a rhyolite), 1% polymineralic (rock) fragments that themselves comprise the same mineralogy as found in this grain population (excluding the felsic volcanic), and trace epidote.

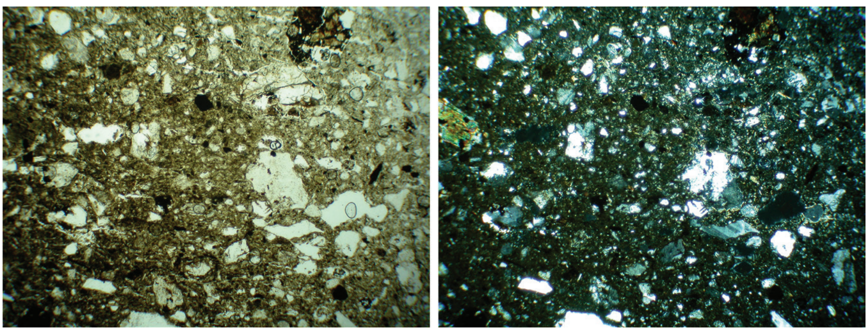


Figure 6: Micrograph, ZU2, Sample #9, plain and cross polarized light, 40X magnification

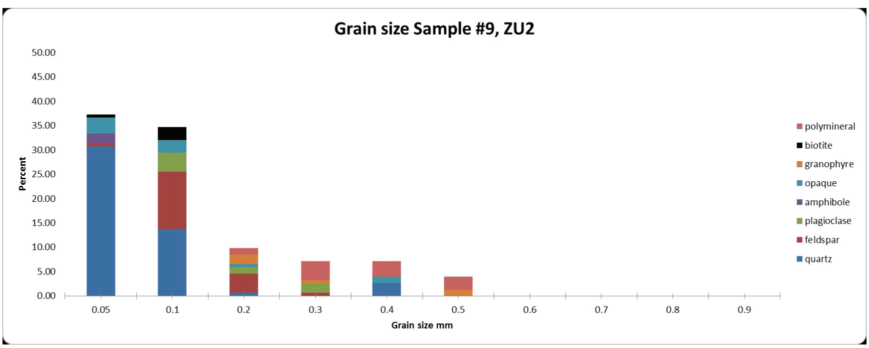


Figure 7: Grain size chart for Sample #9, ZU2

Petrofabric Group Three (ZU3). This includes Samples 1–4 and 7 (Figures 8 and 9). The petrofabric consists of moderately to poorly sorted subangular to subrounded fine sand (average of 0.1 mm) comprising 8–11% sericitized (altered) untwinned (orthoclase) feldspar, 4% plagioclase, 3% perthitic feldspar, 2% quartz, 1% of what appears to be oxidized chlorite, 1% opaques, 1% fine micritic calcium carbonate, and trace amounts of epidote, clinopyroxene, and muscovite mica. Although this seems to be a single population of poorly sorted grains, it was noted that all of the minerals in the list after chlorite were only found in the finer fraction. This suggests that a proportion of the finer fraction was derived from a different source than was the rest of the inclusions, which are from a syenite or monzonite type of granitic rock (quartz-monzonite to be specific).

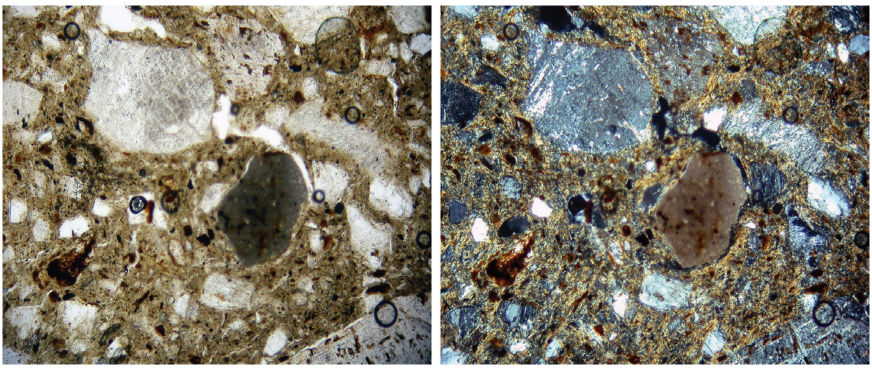


Figure 8: Micrograph, ZU3, Sample #2, plain and cross polarized light, 40X magnification.

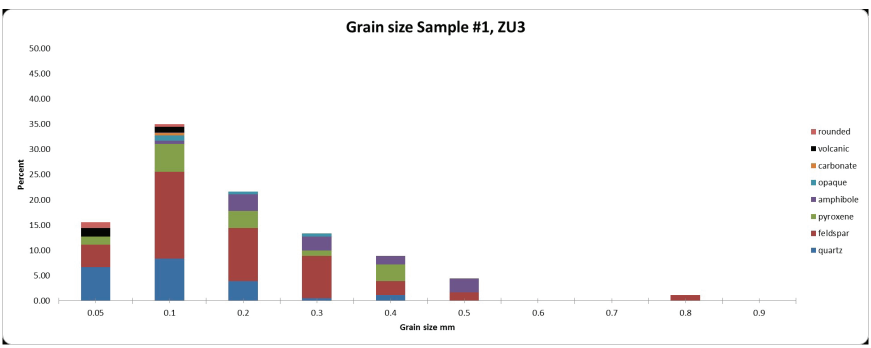


Figure 9: Grain size chart for Sample #1, ZU3.

Petrofabric Group Four (ZU4). This includes Sample 10 (Figures 10 and 11). The petrofabric consists of moderately to poorly sorted, subangular to subrounded fine sand (average of 0.1 mm) comprising 5% quartz, 3% plagioclase, 3% clinopyroxenes, 3% biotite, 2% amphibole, 2% untwinned feldspar (orthoclase), 1% opaques, and trace amounts of muscovite, perthite, and felsic volcanic. Most of the biotite, however, is restricted to the finer portion of the grain size distribution, which is also richer in quartz.

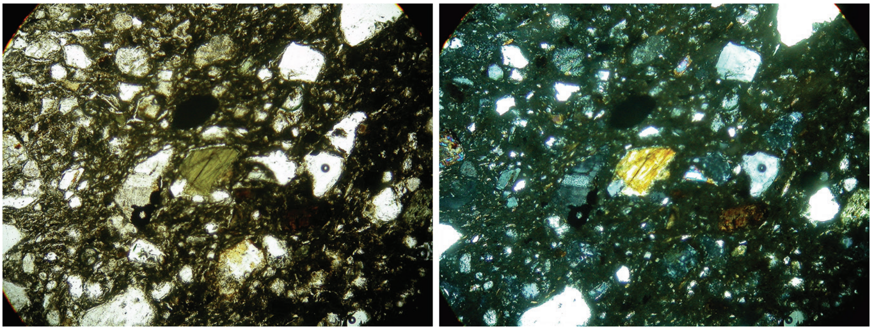


Figure 10: Micrograph, ZU4, Sample #1, plain and cross polarized light, 40X magnification.

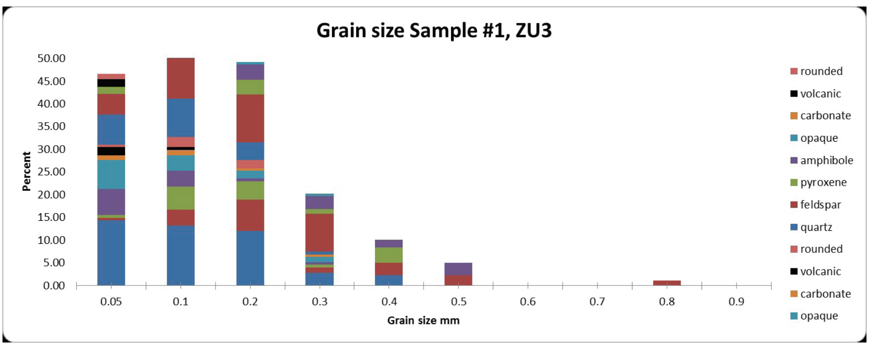


Figure 11: Grain size chart for Sample #10, ZU4.

Discussion and Interpretation

A number of previous studies have examined the petrography of Oaxacan pottery. Shepard (1967) studied the pottery of Monte Albán. Feinman et al. (1989) undertook a preliminary study of Classic and Postclassic period grey wares from a number of sites in the region. Fargher's (2007) study of Late/Terminal Formative to Classic periods covered the region. Minc and Sherman (2011) and Minc et al. (2016) studied natural clays and pottery of the Late Formative to Terminal Formative periods.

Petrofabrics ZU1 and ZU2 are clearly very similar, having essentially the same inclusions and the same grain size distribution but in different quantities. Both have very distinctive granophyric inclusions. Granophyric feldspars represent a distinctive intergrowth of quartz and feldspars and develop under very particular conditions. No other petrofabric in pottery with granophyric inclusions has been reported in the Oaxacan region, but bodies of granophyric rock tend to be small and may not have been obvious in previous geological surveys of the area. We have found one reference to a granophyric rock in Oaxaca, the La Carbonera stock, which is only 300 m wide, and only part of it is granophyric (Solari et al. 2001). It is in the highlands 23 km northwest of Etla. However, similar small intrusions may occur elsewhere undiscovered. Both also have rhyolitic inclusions which may relate to the widespread rhyolitic to andesitic volcanism in the eastern part of the valley, and may relate to a number of ceramic petrofabrics identified in the Tlacolula-Mitla valley. However, as may be seen in Figure 12 (Table with petrofabric percentage mineral abundance), the amount of the fine population in the petrofabrics is radically different, while the coarse population is not just smaller in ZU2, it is proportionally different, with much less granophyric feldspar and volcanic rock. It might be suggested that the petrofabric containing more aplastics may have been prepared in this manner to reduce shrinkage, but in fact both groups of samples are from parts that would have been attached to the cylinder that is at the core of the vessel. This perhaps makes it unfortunate that a sample was not taken from the cylinder for comparison.

Petrofabric ZU3 is dominated by a granitic rock of quartz-monzonite composition that is heavily altered, and so bears some relation to rocks found in the Precambrian Oaxaca Complex on the west of the valley (Keppie et al. 2002, Schulze et al. 2003). Although it is hard to be certain, a petrofabric found in Middle–Late Formative period Monte Albán pottery by Fargher (2007) and the "diorite" petrofabric of Shepard (1967) may be comparable.

Petrofabric ZU4 seems to contain two sources of aplastics like the others, although like ZU3 these do not form two discrete bimodal distributions. The coarser fraction is dominated by plagioclase and clinopyroxenes, with also a higher amphibole content than other petrofabrics.

sample #	quartz	potassic feldspar	plagioclase	perthite	microcline	granophyre	felsic volcanic	epidote	opaque	biotite	amphibole	clinopyroxene	muscovite	other rock fragment	chlorite	carbonate
ZU-3	2	7	3	2	-	-	-	-	1	-	-	tr	tr	-	-	1
ZU-3	2	8	4	3	-	-	-	-	2	-	-	tr	tr	-	-	1
ZU-3	2	9	4	3	-	-	-	tr	1	tr	-	tr	tr	-	1	1
ZU-3	2	9	3	3	-	-	-	tr	2	tr	-	tr	tr	-	tr	1
ZU-1	20	3	-	tr	-	-	-	tr	3	1	tr	tr	tr	-	-	-
ZU-1	2	2	-	-	tr	5	5	-	-	-	-	-	-	2	-	-
ZU-1	18	3	-	-	-	-	-	-	3	1	tr	tr	tr	-	-	-
ZU-1	3	2	-	-	tr	4	4	-	-	-	-	-	-	1	-	-
ZU-3	1	10	4	3	-	-	-	-	1	-	-	-	tr	tr	tr	1
ZU-2	10	1	-	tr	-	-	-	tr	2	tr	tr	tr	tr	-	-	-
ZU-2	3	2	1	-	-	2	1	-	-	-	-	-	-	1	-	-
ZU-2	9	1	-	tr	-	-	-	tr	3	tr	tr	tr	tr	-	-	-
ZU-2	3	1	1	-	-	1	1	-	-	-	-	-	-	1	-	-
ZU-4	5	2	3	tr	-	-	tr	-	1	3	2	3	tr	-	-	-

Table 1: Petrofabric percentage mineral abundance.

Conclusion

The petrographic analysis of ROM object HM 1953 has clearly shown two less-distinct groups (ZU1 and ZU2), and two groups that are very distinct from the others and each other (ZU3 and ZU4) (Table 1). Petrofabric ZU2 is the original petrofabric of the core object. Petrofabric ZU1 is sufficiently similar to ZU2 that it was possibly fabricated in the same place, or at least the same vicinity. However, it is sufficiently distinct that it must originally be from a different object.

The felsic- to intermediate-volcanic-rock outcrops in the east (around Mitla) and to the southeast (east of Ejutla) are a possible source. Further research in the form of a survey for the source of the granophyric rock has the potential to very precisely identify the locale. As the only known granophyric outcrop in the region intrudes into the Precambrian Oaxaca Complex, it may be the area where the volcanics and the Oaxaca Complex meet, in the vicinity of Ejutla, that would be worth investigating. The granophyric and the volcanic rock types are not similar in their petrogenesis, so it may be that two different drainages have merged to form this clay or sand deposit.

Petrofabric ZU3 is clearly from somewhere else, probably the western parts of the region dominated by the Precambrian Oaxaca Complex. Given that the components made of Petrofabric ZU3 are all very similar, but from various parts of the object, it is likely that they were fabricated specifically to restore the

original, presumably by a relatively recent restorer. As such, this petrofabric may be compatible with production at pottery production centres that are still active, such as Santa Maria Atzompa (Shepard 1967; Balkansky et al. 1997). Petrofabric ZU4 is also probably from a very different location. The relatively high content of ferromagnesian minerals (clinopyroxene, amphibole and biotite) makes it unlike anything that has been published on the region.

Petrographic analysis suggests that urn HM 1953 underwent multiple transformations. Exhibiting four definable petrofabric groups, the whole of this ROM object can be taken to represent not only its original Zapotec creators, but possibly their descendants living in Mexico who continue the tradition of ceramic manufacture. Given the global demand for "authentic" cultural objects, the ROM's Zapotec urn is likely representative of many such amalgam pieces in collections worldwide.

References Cited

Alaniz-Alvarez, Susana Alicia, Angel Francisco Nieto-Samaniego, and Fernando Ortega-Gutierrez. 1994. "Structural Evolution of the Sierra de Juárez Mylonitic Complex, State of Oaxaca, Mexico." *Revista Mexicana de Ciencias Geológicas* 11 (2): 147–56.

Balkansky, Andrew K., Gary M. Feinman, and Linda M. Nicholas. 1997. "Pottery Kilns of Ancient Ejutla, Oaxaca, Mexico." *Journal of Field Archaeology* 24 (2): 139–60.

Day, Peter M., Evangelia Kiriatzi, Alexandra Tsolakidou, and Vassilis Kilikoglou. 1999. Group Therapy in Crete: A Comparison between Analyses by NAA and Thin Section Petrography of Early Minoan Pottery. *Journal of Archaeological Science* 26(8): 1025-36.

Fargher, Lane F. 2007. "A Microscopic View of Ceramic Production: An Analysis of Thin-Sections from Monte Alban," *Latin American Antiquity* 18 (3): 313–32.

Feinman, Gary M., Sherman Banker, Reid F. Cooper, Glen B. Cook, and Linda M. Nicholas. 1989. "A Technological Perspective on Changes in the Ancient Oaxacan Grayware Ceramic Tradition: Preliminary Results." *Journal of Field Archaeology* 16 (3): 331–44.

Folk, R. L. 1980. *Petrology of Sedimentary Rocks*. Austin: Hemphill.

Freestone, Ian. 1991. "Extending Ceramic Petrology." In *Recent Developments in Ceramic Petrology*, edited by Andrew Middleton and Ian Freestone, 399–410. British Museum Occasional Paper no. 81. London: British Museum Press.

Keppie, J. Duncan, J. Dostal, K. L. Cameron, L. A. Solari, F. Ortega-Gutiérrez, and R. Lopez. 2003. "Geochronology and Geochemistry of Grenvillian Igneous Suites in the Northern Oaxacan Complex, Southern Mexico: Tectonic Implications." *Precambrian Research* 120 (3–4): 365–89.

Mason, Robert B. 1991. Petrography of Islamic Ceramics. In *Recent Developments in Ceramic Petrology*, edited by Andrew Middleton and Ian Freestone, 185–209. British Museum

Occasional Paper No. 81. London: British Museum Press.

______. 2003. Petrography of Pottery from Kirman. Iran 41: 271-278.

———. 2004. *Shine Like the Sun. Lustre-painted and Associated Pottery from the Medieval Middle East*. Costa Mesa, CA: Mazda Publishers; Toronto: Royal Ontario Museum.

Mason, Robert B., and Lisa Cooper. 1999. "Grog, Petrology, and Early Transcaucasians at Godin Tepe." *Iran* 37: 25–31.

Middleton, A. P., I. C. Freestone, and M. N. Leese. 1985. "Textural Analysis of Ceramic Thin Sections: Evaluation of Grain Sampling Procedures." *Archaeometry* 27 (1): 64–74.

Minc, L. D., and R. J. Sherman. 2011. "Assessing Natural Clay Composition in the Valley of Oaxaca as a Basis for Ceramic Provenance Studies." *Archaeometry* 53 (2): 285–328.

Minc, Leah D., Jason R. Sherman, Christina Elson, Marcus Winter, Elsa M. Redmond and Charles S. Spencer. 2016. *Journal of Archaeological Science: Reports* 8: 28-46.

Peacock, David P. S. 1968. "A Petrological Study of Certain Iron Age Pottery from Western England." *Proceedings of the Prehistoric Society* 13: 414–26.

———. 1970. "The Scientific Analysis of Ancient Ceramics: A Review." *World Archaeology* 1 (3): 375–89.

Pettijohn, F. J., P. E. Potter, and R. Siever. 1987. *Sand and Sandstone*. 2nd ed. New York and Berlin: Springer-Verlag.

Schulze, Carlos Heinrich, John Duncan Keppie, Amabel Ortega-Rivera, Fernando Ortega-Gutiérrez, and James K. W. Lee. 2003. "Geochronology and Geochemistry of Grenvillian Igneous Suites in the Northern Oaxacan Complex, Southern Mexico: Tectonic Implications." *Precambrian Research* 120: 365–89.

Shepard, Anna O. 1939. "Technological Notes on the Pottery of San Jose, Appendix B." In *Excavations at San Jose, British Honduras*, by J. Eric Thompson. Carnegie Institution of Washington, Publication 506, Washington, DC.

Shepard, Anna O. 1956. *Ceramics for the Archaeologist*. Carnegie Institution of Washington, Publication 609, Washington, DC.

Shepard, Anna O. 1967. "Preliminary Notes on the Paste Composition of Monte Alban Pottery." In *La cerámica de Monte Albán*, edited by Alfonso Caso, Ignacio Bernal, and Jorge R. Acosta, 477–84. Mexico: Instituto Nacional de Antropología e Historia.

Solari, Luigi A., Jaroslav Dostal, Fernando Ortega-Gutiérrez, and J. Duncan Keppie. 2001. "The 275 Maarc-related La Carbonera Stock in the Northern Oaxacan Complex of Southern Mexico: U-Pb Geochronology and Geochemistry." *Revista Mexicana de Ciencias Geológicas* 18 (2): 149–61.

Sunahara, Kay Sachiko. 2009. *Ancient Maya Ceramic Economy in the Belize River Valley Region: Petrographic Analyses*. Oxford, England: Archaeopress.

Terry, Richard D., and George Varos Chillingar. 1955. "Summary of 'Concerning Some Additional Aids in Studying Sedimentary Formations' by M. S. Shvetsov." *Journal of Sedimentary Petrology* 25: 229–34.

CHAPTER 11

De-restoration

LAURA LIPCSEI / ROYAL ONTARIO MUSEUM

A **guiding principle** of conservation is to elicit the most information about an artefact in the least invasive way possible. This typically requires gathering information using various non-destructive techniques of analysis. This was the approach taken for the examination of urn HM 1953. Initial investigations began with a detailed visual examination, both with and without a microscope. This was done using normal visible light and by exposing the artefact to ultraviolet radiation to induce potential fluorescence. X-radiography was used to image the internal structure of the artefact. Two methods were used for this part of the investigation. First, digitally captured X-radiography produced 2-D images of the vessel; and second, computed tomography (CT) produced a 3-D X-ray model. Analytical techniques, such as X-ray fluorescence (XRF), were used to gather compositional information about various components of the urn.

Even with the valuable information obtained non-destructively and the improved understanding about the materials and history of the vessel, critical questions still remained. It was clear that the urn had undergone some level of alteration in the past, and, after extensive discussions, we decided to undertake a full-scale "de-restoration" of the vessel to understand what had happened to it during its lifespan.

De-restoration—the dismantling of an object—is invasive and never entered into lightly by a conservator. The benefits and drawbacks of taking apart a restored vessel demand careful consideration. The benefits include a better understanding how the artefact was constructed; the main drawback is potential damage to and loss of original material. We decided to de-restore the urn in order to facilitate ceramic petrography sampling (Chapter 10) and allow for a more detailed study of the pigments and adhesives used on the urn (Chapter 12). Perhaps most importantly, de-restoration allowed us to definitively define the pieces used to make the urn and better understand how they were put together.

The urn's recent history of restoration would be sacrificed and the object converted back to what it likely looked like when it was first unearthed. While only half of the urn would remain, this half could now be critically compared to its possible companion pieces in Berlin and Oaxaca (Figure 1; see also Chapter 13). De-restoration would remove material evidence of the cottage industry devoted to the manufacture of fakes and pastiches active at the turn of the last century; yet, as is standard practice for all conservation activity, samples of all materials, including those identified as part of restoration, would be taken and reserved for analysis. All parts of the urn would be disassembled and appropriately stored with the object for future study. The whole process would be fully documented with written and photographic records. If there was ever a desire to revert the object back to the way it had been restored, conservators could do so using the fragments that had been reserved and stored with the accessioned object.

Figure 1: Ethnologishes Museum, Berlin, IV Ca 2836.

Ancient Zapotec Repairs?

Recognizing early repairs requires knowing what materials were available in fifth century Oaxaca, and how objects may have been repaired in antiquity. Very little, if anything, has been written about ancient repair techniques and materials of the Zapotec, if in fact vessels were repaired. Although there are reports that fragmentary urns were reused and repainted (see Chapter 3), there has been no comprehensive survey or study of ancient repair techniques and materials of the ancient Zapotec. Literature has traditionally focused on objects from the ancient Mediterranean—from Egypt, the Near East, Greece, and Rome. Studies describe various and sundry repairs using bituminous materials, ancient adhesives made from tree and plant gums and resins, and the mechanical means for joining fragments using lead staples and cord secured with bitumen.

Essays on ancient and modern repair techniques have been compiled in an impressive book entitled, *Holding it All Together: Ancient and Modern Approaches to Joining, Repair and Consolidation* (Ambers et al. 2009). Perhaps most relevant to our current study is the work by conservators at the Arizona State Museum who have documented the prehistoric and ethnographic repair techniques and materials used on ancient southwestern Native American pottery, involving creosote lacquer and pine tree resins as adhesives. It would not be unreasonable to assume that the ancient Oaxacans may well have used similar plant materials to repair their vessels. Perhaps they used the cactus juice of the *Opuntia* genus—a material still used today to impart workability and stickiness to wall plasters and as an adhesive in basic pottery repairs.

This brings us to the assumption that the ancient Zapotec would have repaired and reconstructed their ancestral urns. Other than a few references to the use of stucco for minor repairs and for cementing urns inside niches of a tomb (see Chapter 3), there has been no documented evidence to support their repair or restoration in antiquity. Recent work by museum conservators nonetheless suggests that ancient repairs on the urns may have been more frequent than we realize.

Alderson (personal communication, 2016) describes the possible ancient repair of a Zapotec urn at the site of Xoxocotlán. The conservator describes the reattachment of a day glyph to a vessel using the same stucco employed to cement the urn in place over the entrance of its associated tomb. Urn 917.4.63 (Figure 2) from the collection at the Royal Ontario Museum appears to have been treated in a similar way. It too has remains of stucco on its back and sides, possibly as a result of having been repaired and/or set into the niche of a tomb. Alderson also states that these urns were repainted and reused from a previous burial or other context. She cites an example of an urn with a broken edge, indicating that it was reused nonetheless, despite having lost some of its parts. On another vessel, found above the entrance to a tomb at Xoxocotlán, Anderson documents an example that has more than one application of paint. While

Figure 2: Three views of ROM urn 917.4.63 showing stucco at the back and sides.

much of the pigment was found to be applied in a single layer directly onto the ceramic body, in another area, a second layer of red paint was found on top of an intermediary layer of white paint or stucco, suggesting a second campaign (Alderson 2002, 148).

De-restoration of HM 1953

The spurious parts of HM 1953 identified in Chapter 5 were reviewed before anything was removed from the urn. While examining the urn, my attention was drawn to areas of discoloured and flaking restoration materials. These are very clearly not ancient repairs of the Zapotec, who would have used local clays, but were instead modern alterations with what looks like some kind of synthetic or polymer that had been added to the clay to impart plasticity and workability. Furthermore, ceramic body parts and fragments were made of different clays with different colours in areas that should have been consistent and contiguous. For example, the clay used for the shoulders of the figure did not match the colour or fabric of the clay used in the torso, and the clay used for the legs was different from that of the cylinder. Furthermore, the whole object was covered with a wash of mud and soil intended to camouflage these differences.

According to Sellen (Chapter 3), the fragment attached to the headdress was not a day glyph, but rather a fragment from another vessel that represents a bird's wing. The fragment was perhaps mistakenly attached to the headdress by a restorer because of its resemblance to day glyphs found on other figural urns, or was simply used to fill in the space with a random motif. When comparing the lap plaques to the false day glyph fragment, it was obvious that the plaques had

been made from a mould of the fragment, since all three have the same form and even bear an identical mark to one found on the headdress fragment. The three lap plaques are also approximately a third smaller in size than the bird-wing fragment: a result of the coefficient of shrinkage caused by firing clay in a kiln. The lap plaques, thus, did not belong to the vessel either.

Non-destructive techniques of analysis using ultraviolet radiation, X-ray fluorescence (XRF), X-radiography, and computed tomography drew attention to areas worthy of further exploration and investigation. UVA highlighted anomalies in the surface, illuminating materials in the restoration that were different in composition and age to the original. X-ray fluorescence, a surface technique, gathered elemental information about the clay used in various parts of the urn. XRF data was used to establish groupings based on the composition of the various parts of the urn and found that potentially three different clay sources were used in the urn. X-radiation and CT scanning have also revealed areas of different densities, supplying information about how the urn was constructed and repaired. These imaging techniques clearly identified the radio-opaque modern wire used extensively to attach arm and leg fragments.

Before deconstruction, five areas of pigment were sampled for analysis. Because of the friable nature and degree of preservation of the pigment left on the surface, samples were taken by gently scraping the surface with a clean scalpel under magnification. A thin-section (used to show subsequent depositions of polychromy) was not required, since there was only a single, thin, friable layer of colour. The five samples of pigment were analysed by Shugar (see Chapter 12). The red pigment was identified as cinnabar and hematite. It is not uncommon to find a mixture of both colours used on the same object since each has its own unique optical property that can be used to achieve different effects of hue, saturation, and intensity (Magaloni Kerpel 2010).

I started de-restoration with the lap plaques (Figures 3a–c). The plaques had been given a light grey clay wash (to integrate the pieces with the rest of the urn) and attached with a brown putty that was found to soften with deionized water. Cotton swabs soaked with water were used to soften the putty before freeing the plaques with a scalpel. After removing the plaques, a loincloth "bridge" of a notably darker, coarse black, fired ceramic was exposed. Under the plaques, I identified and removed an area of repair consisting of modern brass wire and more of the same brown putty.

Going forward, any repair with brown putty and/or wire was identified as modern and could therefore be removed with confidence. This would apply next to the figure's arms and legs (Figures 4 and 5). The coarse black ceramic fabric of the figure's left arm was discovered to be very similar to that of the loincloth and was possibly from the same period of restoration (Figure 6a and b). The figure's right arm, however, was attached differently. The material used was finer and of a lighter colour, a light brown/orange (Figure 7). There was a slight possibility that the arm was ancient, but it did not seem to belong to the urn as the fabric was remarkably different (see Chapter 10).


3a


3b


3c


4


5


6a


6b

Figure 3a: Row of lap plaques.

Figure 3b: Brown putty and wire under plaques.

Figure 3c: brown putty attaching the loincloth (view from below).

Figure 4: brown putty at wrist.

Figure 5: Excavating the legs removing brown putty and wire.

Figure 6a: Black proper left arm.

Figure 6b: Black arm detail.

Figure 7: Orange brown proper right arm.

After removing the legs and examining the methods of their attachment to the cylinder, it became apparent that the legs did not fit to the original cylinder. Although they had appeared to be of an appropriate height, there were large gaps in the joins that had been filled and concealed by the putty (Figure 8). The footprint of the abutting legs did not line up with the area roughed out at the side of the cylinder to take the legs' join. It was also quite strange that there were no break edges—just a smooth, neatly luted, almost-finished edge where the legs had once been attached (Figure 9a and b). One would have anticipated a broken edge of fractured ceramic, as on the Berlin urn with its jagged, jutting piece. Comparisons with other ancient urns, however, attest to the same pattern of detachment as the Toronto urn, that is, along a luted join—the result of a neat, clean separation of the leg from the cylinder, and not a rough break in the material (Figures 10a–b, 11a–c, and 12a–c depict three comparable urns in the ROM's collection.) The smooth edges of the original attachment area on the ROM vessel prompted questions: could this represent a weak bond in the attachment, one that merely separated neatly at the join when the legs had fallen off after deposition? Or could it be that these legs were made after the originals had broken off the cylinder? What was obvious was that there had been a set of legs attached to the cylinder when it was fired because those legs had protected the area and left it unoxidized: this resulted in a characteristic, lighter grey coloured area (Figure 13).

The answer to these questions was revealed once the black ceramic loincloth "bridge" was removed: the angle of the loincloth jutting out from the cylinder did not match the angle of the loincloth fragment preserved at the front of the figure's crossed legs. This has major implications, suggesting that the cylinder and the legs were indeed not part of the same object. Once I had carefully separated the legs from the cylinder, the front portion of the crossed legs was also dismantled. This included a small knee fragment made from the coarse black ceramic that is different from the legs, but the same fabric as had been used to make the loincloth bridge and figure's left arm.


8


9a


9b


10a


10b


11a


11b


11c

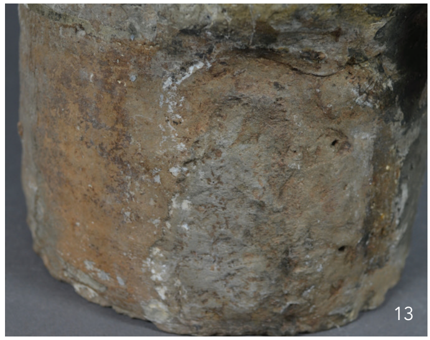


Figure 8: Gap at leg joins.

Figure 9a: Proper left leg abutting end join in foreground.

Figure 9b: Proper right leg abutting end join in foreground.

Figure 10a: HM 1891.

Figure 10b: HM 1891 lying down, view of luted join.

Figure 11a: HM 1931.

Figure 11b: HM 1931 dismantled.

Figure 11: HM 1931 legs.

Figure 12a: HM 1949.

Figure 12b: HM 1949 lying down, detail of luted join.

Figure 12c: HM 1949 lying down, detail of luted join.

Figure 13: Spot of light grey unoxidized in fire.

Next were the figure's shoulders. Completely covering the shoulders was a grey skim coat of the clay-like material that was now heavily cracking and lifting from the surface (Figure 14a–c). This material was water-soluble; it was easily softened with moistened cotton swabs and then removed with scalpels and dental tools. In some instances, the grey material swelled to an almost plastic or rubbery consistency, which indicated that it contained perhaps a modern plastic or polymer material. It certainly did not behave like unadulterated native clay. Shoulder fragments were attached with this grey material and so were easily removed after soaking with cotton swabs moistened with deionized water. Noteworthy was the fact that the shoulders did not fit neatly with the broken shoulder fragments jutting out from the cylinder. In fact, the figure's left shoulder was cut with notches to allow the attachment to splay open to an appropriate size when pressure-fitted into place (Figure 15a–c). Underneath the thin grey skim coat, the shoulders appeared to have been made of the same coarse black ceramic as the loincloth, proper left arm, and proper right knee—a fabric much darker than the body to which they were attached. It could be assumed, therefore, that the skim coat had been applied as a way to conceal/camouflage the difference in colour and integrate the shoulders to make the urn appear whole.

Next, the headdress flanges and the figure's left ear and ear spool were removed (Figure 16a–b). They had been attached with the same grey clay-like material used on the shoulders. There was also some stucco or plaster used as a skim coat to blend the repair of the flanges. The flanges and the proper right ear appear to be made of the same coarse black ceramic material with large inclusions that was used in several of the aforementioned fragments, though these other fragments were unevenly fired from an orange-red to a grey-black colour. Noted was the fact that the attached headdress flange was slightly too small, requiring a fill to bring the flange into line with the top of the headdress to which it was attached.

Remarkably, the ear and the ear spool appear to be a composite repair—part ancient (the ear spool) and part recent (the ear itself) (Figure 17a–b). The ear spool has the characteristic wear and deterioration expected of an ancient artefact and is in such poor condition that it stands out from the ear to which it is attached, and indeed the rest of our urn. It also exhibits red pigment on its surface, and even underneath the restoration material that was used to repair it. The ear spool, while likely ancient, did not belong to this urn. It differs from the other ear spool, which has had a slightly different treatment, has a centre of a different diameter, and is made with a different clay. Conceivably, when putting this urn together, the restorer found the ancient ear spool and incorporated it into its restoration. Ear spool fragments are apparently abundant, even today found scattered across archaeological sites (Sellen, personal communication 2016).

The last piece detached was the nose (Figures 18a–e). The grey fill material surrounding the nose was easily scraped away with a scalpel after it was soaked

with water and swelled. The large gap that was revealed around the nose made it quite apparent that the nose was not original to the piece—it simply did not fit. The outline of the break did not correspond with the extant nose. The nose fragment was also quite different in material and construction than the rest of the figure's face. The nose was a solid mass of unevenly fired clay, with an orange-red to dark grey-black colour which matched that of the other fragments mentioned thus far: the loincloth, proper left arm, proper right knee, shoulders, flanges, and proper left ear (see Chapter 6 for extensive evidence of repair of the nose). This contrasted with the rest of the face, which had been executed in a fine orange-buff to light-grey coloured clay in a thin-slab construction, and to which the figure's facial features had been attached. Finally, the very tip of the nose was modelled with an unfired and extremely water-soluble clay-like material with large inclusions.

Once disassembled (Figures 19 and 20), break edges and the ceramic core were exposed (Figure 21a–b). This provided useful information about how the object was made and its firing conditions. At the left side of the cape and in the nose area, for example, a light-grey core could be seen at the centre of the ceramic matrix with a light orange-buff colour toward the surface of the (oxidized) ceramic body. Disassembly also allowed for thin-section petrography of previously inaccessible areas (see Chapter 10), and for the collection of pigments, adhesives, and restoration materials (see Chapter 12).

The grey clay-like material was identified as a mixture of kaolin, calcium carbonate, and a proteinaceous glue, possibly rabbit skin, a concoction typical of early restoration materials and recipes from the early twentieth century. The animal glue was added to improve the workability and plasticity of the mixture to which it imparted a certain stickiness. Shugar's and Ploeger's findings in Chapter 12 are supported by what we see under ultraviolet light, where these areas fluoresce a bright lilac colour characteristic of proteinaceous adhesives.

The brown putty was identified as a blend of clay, calcium carbonate, and possibly some polyvinyl acetate (PVA). As stated earlier, this brown putty was extremely uniform and homogenous in colour and texture, almost as if it were a commercially prepared or a modern restoration putty. This putty did not fluoresce under UV light. This is consistent with what has been observed of PVA under UV illumination—it has a weak or non-existent fluorescence.

Adhesives found on HM 1953 were predominantly PVA (available by 1940 as an adhesive) with the use of cellulose nitrate (available in the late nineteenth century) in isolated areas, such as the front of the legs and the figure's left arm. In many areas, PVA was found underneath the brown putty and associated wire, for example, under the putty and wire attachment of the legs, under the lap plaques and at the attachment site of the bird-wing motif at the top of the headdress. This suggests that the adhesive may have been used in an initial attempt to repair the urn, only to be replaced by the later use of the wire and putty.


14a


14b


14c


.M·1953
15a


.M·1953
15b


15c


16a


16b

Figure 14a: Grey restoration material covering shoulder.

Figure 14b: Grey clay like restoration material.

Figure 14c: Flaking grey clay like restoration material.

Figure 15a: Notches cut to fit shoulder fragment.

Figure 15b: Splay of shoulder fragment.

Figure 15c: Proper left shoulder cleaned of clay and join.

Figure 16a: Cracking restoration material back of proper left flange.

Figure 16b: Cracking restoration material on proper left flange.

Figure 17a: Proper left ear and earspool with cracking and flaking restoration material.

Figure 17b: Composite construction: ancient earspool and misfired ear fragment.


18a


18b


18c


18d


18e


19


20


21a

Figure 18a–d: Removal of the grey clay-like material used to attach the nose.

Figure 19: Fragments of black coarse ware removed.

Figure 20: Light brown fragments removed including legs and proper right arm.

Figure 21a: Grey core observed at broken edge.

Figure 21b: Grey core revealed in break in the nose area.

Figure 22: Cut section showing grey core, buff exterior.

Conclusions

The findings from disassembly suggests that there were two restoration campaigns for urn HM 1953. During the first restoration campaign, the original object— a cylinder with a torso, face, and headdress (Figure 24)—was paired with an ancient fragment to replace a lost day glyph. Then, the restorer added legs and an arm on the figure's right side that appear to be of the same and possibly ancient fabric, perhaps taken from another urn. An assemblage of fragments was then added, all made from the same, unevenly fired, coarse black pottery with large white inclusions. These include the lap plaques (made from the bird-wing motif), the loincloth, knee, proper left arm, shoulders, nose, proper left ear and ancient ear spool, and headdress flanges.

This campaign is believed to have occurred in Mexico, where the restorer used a mixture of clay and animal glue, and some limited use of plaster (e.g., on the proper right headdress flange). A final wash of a grey clay slurry and orange soil was applied to the surface to help integrate the new material visually and unite the whole. This happened some time during the early part of the twentieth century because of the types of materials used by the restorer.

Inventory records at the ROM indicate that the object remained in Mexico for several years until its transport to Canada in the 1930s. It is suggested that the object may have broken in transit, necessitating its repair by ROM conservators sometime after its arrival. This second restoration campaign involved materials newly available at the time, e.g., PVA adhesive and a brown PVA putty and wire to reattach the legs, arms, loincloth, lap plaques, and bird-wing motif.

The deconstruction of HM 1953 has proven extremely useful in understanding the urn as a pastiche of disparate parts, restored with materials dated to the last century (Figures 23 and 24). Its dismantling provided access to materials and surfaces that could be isolated, analyzed, and more closely scrutinized. This work revealed materials different in age, composition, and construction. Stripped of its modern parts, we have a better understanding of what this object looked like when it was first unearthed, and a better sense of how such fragmentary finds were restored in the first half of the twentieth century both in Oaxaca and at the Royal Ontario Museum.

Figure 23: HM 1953 before derestoration.

Figure 24: HM 1953 after derestoration.

References Cited

Alderson, Samantha. 2002. "A Technological Study of the Painted Surfaces of Zapotec Urns from Xoxocotlán." In *AIC Objects Specialty Group Postprints*, Vol. 9, compiled by Virginia Greene and Patricia Griffin, 146–60. The American Institute for Conservation of Historic and Artistic Works.

Ambers, J., C. Higgitt, L. Harrison, and D. Saunders, eds. 2009. *Holding it All Together: Ancient and Modern Approaches to Joining, Repair and Consolidation*. London: Archetype Publications Ltd.

Magaloni Kerpel, D. 2010. "The Hidden Aesthetic of Red in the Painted Tombs of Oaxaca." *RES: Anthropology and Aesthetics* 57/58: 55–74.

CHAPTER 12

Pigment and Adhesive Analysis

AARON SHUGAR AND REBECCA PLOEGER / SUNY – BUFFALO STATE, ART CONSERVATION DEPARTMENT

Artefacts in museum collections often undergo several alterations in their lifetime, whether through natural ageing during storage and display, or through conservation treatment. This is quite different from the alterations an artefact might undergo during its active lifetime, from burial/disposal to excavation. Distinguishing between these alterations and potential interference from post-excavation manipulation (i.e., repairs by collectors/dealers) is critical in understanding the history of an object.

During its manufacture, Zapotec effigy HM 1953 may have undergone several firings and multiple applications of pigment or glazes, or it may have been repaired by the original potter if a component was found to be inappropriate or was damaged during firing. Archaeological ceramics that are disposed of once they have served their original purpose are often found broken when excavated, and can exhibit extensive deterioration from exposure to the elements or from changes in relative humidity (these can release soluble salts that cause flaking and delamination). Often, collectors will attempt to "restore" broken artefacts, either by replacing missing or damaged pieces with new parts, or with existing fragments from another similar artefact. Once the artefact becomes part of a museum collection, it may undergo one or several conservation campaigns to stabilize it and/or to deal with the potential issues mentioned above.

When determining if and how to conserve an artefact, it is invaluable to have investigated the technical aspects of its manufacture and characterized its constituent materials as best as possible. For the Zapotec effigy, this includes characterizing not just the ceramic components, but the potential pigments, glazes, soluble salts (if present), jointing technology, and original or "modern" adhesives used during repairs. This not only leads to a better understanding of the technical skill and cultural milieu of the original potters, but also gives a conservator a wealth of information that can be used to properly conserve and stabilize the artefact, so that the museum visitor can learn from it for years to come.

It was apparent through visual assessment, non-invasive analysis, and subsequent physical dismantling, that this effigy had undergone extensive restoration or alterations in the past. It was decided that physical sampling of several components was required to better understand the manufacture of the artefact, and what materials were used in its initial construction as opposed to what were used for its repairs. Sampling an object is not always desired but it is often necessary, and these decisions are always carefully made in consultation with conservators (in this case with object conservator Laura Lipcsei). Physical sampling targeted specific areas where it was unclear which materials were used and when they were potentially introduced. In particular, there were questions regarding the presence of adhesives from modern repairs. Questions to be addressed included which adhesives were present, when they could have been used, and how they could be safely removed. Questions were also raised about what materials were used to replicate losses in the main ceramic body. In addition, the team wondered if any residual pigment remained on the surface as decoration from the initial fabrication. Several analytical techniques were employed to answer these questions, including X-ray fluorescence (XRF), Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, and optical microscopy. The wealth of information gained from such scientific analyses aids conservators in performing their duties and scholars in better defining the context and potential manipulation of the object.

These analytical techniques are ideal methods for the identification of the materials under investigation. XRF (as described in Chapter 9) provides the elemental composition of a sample (from magnesium to uranium) (Janssens et al. 2000; Shackley 2011; Shugar 2013). Fourier transform infrared spectroscopy (FTIR) is an ideal method for characterizing various organic compounds, including many of the adhesives used in conservation and industry (de Groot and van Oosten 2012; Learner 2004). Raman spectroscopy complements FTIR, but can also be used to better characterize inorganic compounds (Stuart 2007). Optical microscopy is one of the oldest and most trusted analytical techniques for the identification of materials. It takes advantage of the properties of light as it interacts with minute samples, resulting in unique signatures that can be viewed under high magnification. This technique is ideal for the identification of minerals and pigments (Burgio and Clark 2001; Eastaugh et al. 2008).

Scientific Methodology

Several of these techniques were used in combination to identify potential pigment that remained on the surface of the effigy, namely XRF, Raman spectroscopy, and optical microscopy. Each technique provides different information about the samples collected; together they can confirm the types of pigments that were applied to the effigy.

VIBRATIONAL SPECTROSCOPY

Vibrational spectroscopy (FTIR and Raman) uses light (infrared (IR) radiation (FTIR) or specific laser wavelengths (Raman) to identify chemical bonds in a molecule (Stuart 2007). In the simplest terms, the light (energy) interacts with the sample, and some of the energy is absorbed by the molecular bonds in the sample. Each type of chemical bond and functional group will absorb the energy at a different wavelength. What is measured is the difference between the original energy, and what is absorbed, transmitted, or released by the samples. This will produce a spectrum, which is a chemical profile of the sample, and in a way it can be considered a molecular 'fingerprint' that can be carefully interpreted and scanned against a database of known compounds. These two techniques are complimentary to one another. Some molecules are more responsive to FTIR and others are more responsive to Raman. Together, one can get a complete picture of the molecular fingerprint of an unknown compound.

X-ray fluorescence spectra were collected using a Bruker ARTAX 400 energy-dispersive X-ray spectrometer system. The excitation source was a rhodium (Rh) target X-ray tube with a beryllium (Be) window 0.2 mm thick, operated at 45 kV and 800 µA current. The X-ray beam was directed at the artefact through a masked aperture with diameter 1.0 mm. X-ray signals were detected using a Peltier-cooled XFlash silicon drift detector (SDD) with a resolution of 146.4 eV. Spectral interpretation was performed using the Bruker ARTAX Control software. Spectra were collected over 60 seconds live time.

Dispersive Raman spectra were collected on a Bruker SENTERRA Raman microscope using either a 785 nm excitation laser operating at a power of 25 mW at the source, or a 633 nm excitation laser operating at a power of 2 mW at the source. A 10× lens objective was used to focus the excitation beam to an analysis spot of approximately 10 µm directly on the surface of the pigment particles. The resulting Raman spectra are the average of 20 or 30 scans at one-second integrations each. Spectral resolution was 9-3 cm^{-1} across the spectral range analyzed. Spectral spikes due to cosmic rays were removed and baselines adjusted as necessary using Opus 7.2 software. Sample identification was achieved by comparison of the unknown spectrum to spectra of reference materials.

Optical microscopy was carried out on a Leica DM 750 polarized light microscope equipped with transmitted polarized light. Images were taken on Leica LAS software in both plane polarized light and cross polarized light with lens objectives of 10×, 20×, or 40×.

In areas that showed signs of prior adhesive restoration, two FTIR methods were employed. Both transmission FTIR and attenuated total reflection (ATR) FTIR were employed to identify eight samples of adhesives, plus additional samples of structural materials. Infrared spectra were collected using a Continuum microscope coupled to a Nicolet 6700 FTIR spectrometer (Thermo Scientific). For transmission FTIR, samples were prepared by flattening them in a diamond compression cell (Thermo Spectra Tech), removing the top diamond window, and analyzing the thin film in transmission mode on the bottom diamond window (2 mm by 2 mm surface area). A square microscope aperture approximately 100 µm by 100 µm was used to isolate the sample area for analysis. The spectra are the average of 64 scans at 4 cm^{-1} spectral resolution. Correction routines were applied as needed to eliminate interference fringes and sloping baselines.

For ATR-FTIR, infrared spectra were collected using a Nicolet 6700 FTIR spectrometer (Thermo Scientific) with a Thermo Scientific Smart iTR ATR accessory. Samples were analyzed by pressing them against the Diamond ATR crystal. The spectra are the average of 32 scans at 4 cm^{-1} spectral resolution. An ATR correction routine was applied to compensate for variations in penetration depth with wavenumber. For both methods, sample identification was aided by searching a spectral library of common conservation and artists' materials (Infrared and Raman Users Group, http://www.irug.org) using Omnic software (Thermo Scientific).

Pigment Identification

Previous studies of Mesoamerican ceramics have shown some consistent pigments used for decoration of vessels and architectural features (Alderson 2002; de Ágredos Pascual et al. 2011). These pigments include basic calcium carbonate for whites, carbon for black, iron oxides for red and yellow, and mercuric sulphide for red (see Chapter 3). These mineral pigments are easily obtainable in the geographical region, but their concrete identification can be made more difficult by the fact that several also occur in the clay body sources. In addition, these pigments are often under-bound and friable so there is a higher chance of loss during burial or subsequent treatment (whether professional or by a collector preparing an object for sale). Even so, some remnant of pigment may still exist in isolated locations, as was thought on effigy HM 1953,

Upon initial visual examination of the urn, several areas appeared to have additional colouring associated with original pigmentation added during manufacture. These areas were few and far between, suggesting that either no pigment was ever applied to the surface, or if pigment was applied, it was potentially removed during burial or by previous handling and treatment. These initial observations were clarified when dismantling and cleaning revealed clear areas of a richer, red colour than the base ceramic. No additional colours (i.e.,

black, white, or yellow) were identified. Samples were taken by scraping the loosely bound red-coloured pigment directly from the urn. A total of six samples were removed for analysis (Figure 12.1).

Figure 1: Zapotec effigy urn HM 1953 – areas of pigment removal.

Findings

Most of the scrapings showed little evidence of pigment present. The fact that limited pigment remains on the urn is not surprising (for the reasons stated above), especially if it had been altered in any way (i.e., made a pastiche or reworked). Pigment application can occur at various points in the manufacturing process, either pre- or post-firing, but post-firing application is typical of what is known about the ceramics methods of the ancient Zapotec. Pre-fired pigments tend to be used for glazes, while post-firing application can be in the form of a slip (pigment added to a clay matrix in which the object is "painted" or "dipped"), or mixed with a clay and/or minimal binder (if any) and applied to certain areas of a vessel (Rice 1987). Suggested red pigments would include iron oxides (i.e., hematite) or cinnabar (mercuric sulphide). Both have been recorded as being used in Mesoamerica and both were available from the

mineral resources in the region (Alderson 2002; de Ágredos Pascual et al. 2011). They look somewhat similar, but cinnabar tends to be a bit brighter and richer than hematite, which can look more like a deep blood red.

The particles sampled were very small and friable. Initial visual examination under a stereomicroscope clearly showed red pigment present in samples 1, 2, 3, 5, and 6. Samples were first examined using XRF to determine the elements present. It can be difficult to ascertain whether or not the presence of iron in a sample is related to hematite used in red pigment, as this element is also found in high concentrations in the clay body of most ceramics or in a unifying slip. Thus, areas of high iron (Fe) concentration determined by XRF in Sample 5 (Figure 12.2) were further analyzed through fine microscopic inspection and Raman spectroscopy. Raman spectroscopy of samples 2, 3, 5, and 6 (Figure 12.1) showed excellent matches to hematite in the RRUFF database (Lafuente et al. 2015) (see Figure 12.3). The result for sample 4 was inconclusive.

These findings were confirmed using polarized light microscopy (PLM), and sample 4 was in fact determined to be hematite. All the samples showed characteristic optical and morphological features for hematite (Eastaugh et al. 2008). Under plane polarized light, the particles appear variable is size and have an opaque deep red color. Under crossed polars the pigment has strong internal reflection and is somewhat birefringent (Figure 12.4). Sample 1 was visually a brighter red under the stereomicroscope. XRF analysis revealed peaks for mercury suggesting the presence of cinnabar as a pigment (Figure 12.5). Both Raman spectroscopy and PLM confirmed that sample 1 was indeed mercuric sulphide. Raman spectroscopy confirmed this with a clear match to a known spectrum for mercuric sulphide, vermillion (Figure 12.6).

PLM was used to determine whether the mercuric sulphide in sample 1 was in the form of processed vermilion or the natural mineral cinnabar (see Figure 12.1 for location). Wet processed vermilion has very fine, uniform, consistent particles while cinnabar has particles more diverse in size and shape. In addition, cinnabar is often found in association with other minerals, in particular calcite (Eastaugh et al. 2008). Under plain polarized light, the mercuric sulphide in sample 1 glows a bright red and shows variable particle size, and natural fracture lines, all characteristics of cinnabar. The light pink coloured particles are calcite. Under crossed polars, the calcite appears a bright white while the cinnabar glows a bright red having high birefringence and internal reflection (Figure 12.7).

An attempt was made to identify if any binder was used with the pigment. Typical binders from the region of manufacture and chronological period come from either oils extracted from insects or natural plant resins, such as gum arabic or other plant gums (Haude 2013). They are often used sparsely and can be difficult to identify when there has been surface degradation of the artefact, or, as in our case, when all the pigment found was seriously under-bound. Transmission FTIR was used as the sample sizes are submicrogram in size, but the findings were inconclusive.

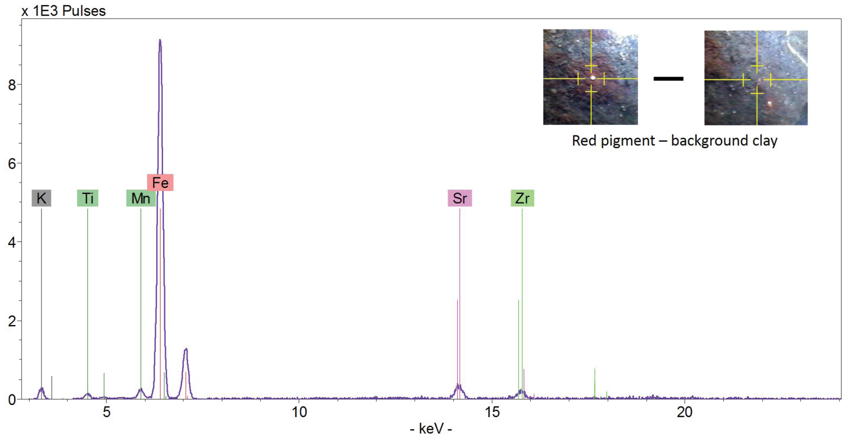


Figure 2: XRF spectrum of pigment sample five showing the subtraction of the spectrum on the red pigment less the spectrum on the base clay body. The results show the main element associated with the red pigment is iron. (Other elements are linked to the plastic bag surrounding the sample.)

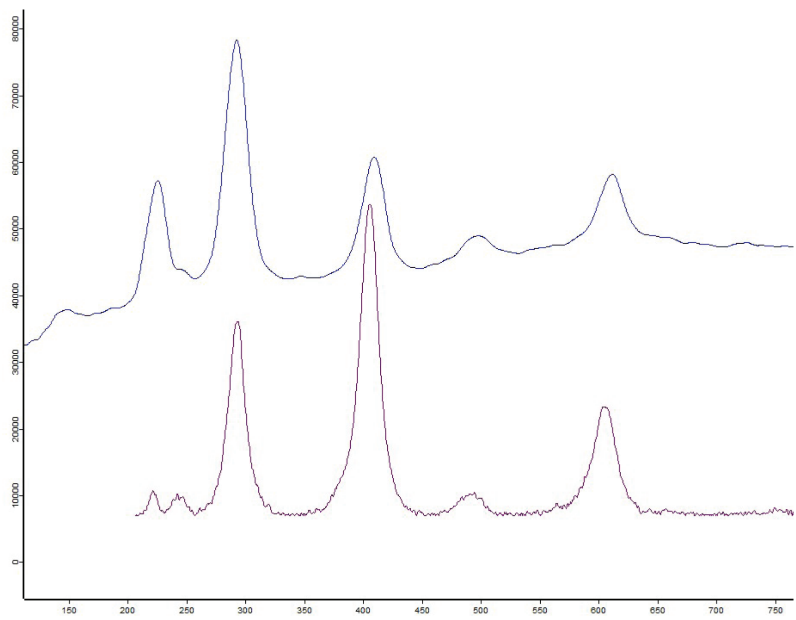


Figure 3: Raman spectra showing the spectrum for pigment sample 5 (blue) and reference spectrum for Hematite (R040024 – RRUFF database).

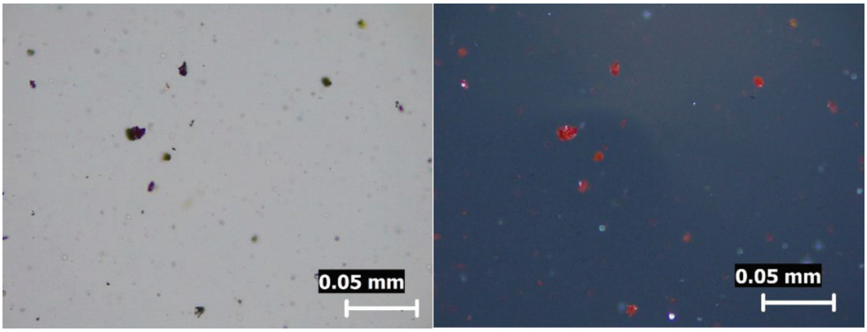


Figure 4: Plane polarized (left) and crossed polarized (right) images of pigment sample 1.

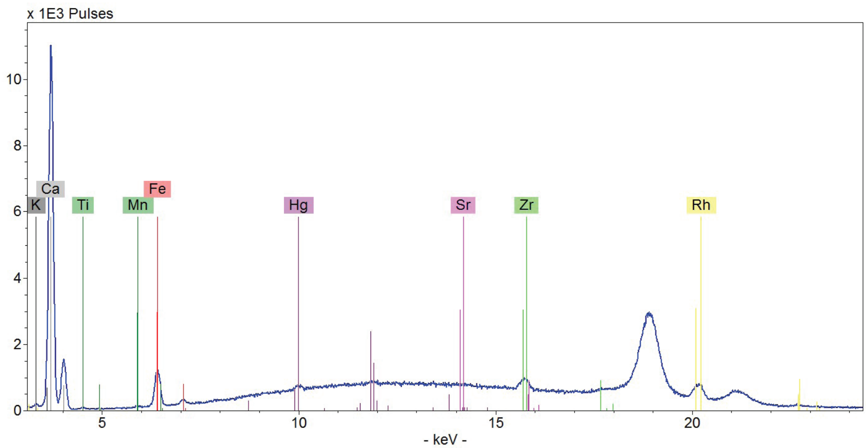


Figure 5: XRF spectrum of pigment sample one showing small peaks for mercury (Hg) suggesting the presence of cinnabar.

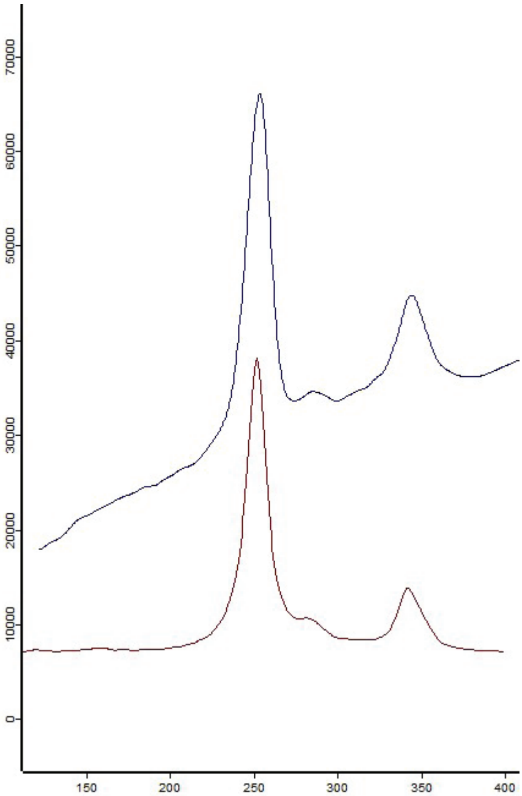


Figure 6: Raman spectrum showing pigment sample 1 (blue) and a reference spectrum for vermilion (UCL database).

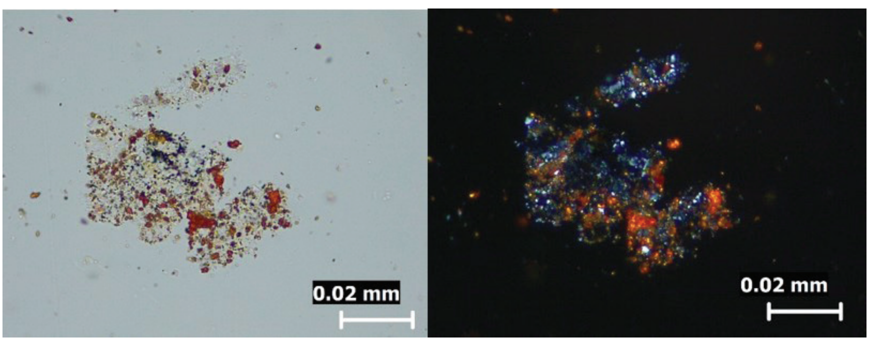


Figure 7: Plane polarized (left) and crossed polarized (right) images of pigment sample 1 showing key morphological and physical characteristics for the mineral cinnabar.

Identification of Materials

Adhesives that may have been used by the initial potters include ceramic slips, or materials used for binders as discussed above. Any semi-synthetic (late nineteenth century or later) or synthetic adhesive (twentieth century or later) found is an indication of an alteration, or of prior conservation treatment to the vessel. One of the best ways to investigate different materials on artefacts is to irradiate the object with ultraviolet A (UVA) radiation (Figure 12.8). UVA irradiation (325 nm irradiant source) will cause certain materials to fluoresce, emitting light across the visible spectrum, which is interpreted by the human eye as a colour (see Chapter 5). The specific fluorescence can be attributed to different materials (Down et al. 1996; Nel 2006). For example, shellac, an insect secretion used in many applications (e.g., LP records, varnishes, adhesives) looks clear or brownish in visible light, but when irradiated with UVA, it looks bright orange (Nel 2006). Although UVA fluorescence cannot definitively identify a material, it can provide key insight into where new or different materials are present. This, in turn, can direct conservators and scientists to areas of interest for physical sampling and further chemical analysis. Under UVA irradiation, the Zapotec vessel showed areas of very distinct and different fluorescence. These

Figure 8
UVA irradiation of Zapotec showing fluorescence (bright blue, green, orange, and yellow) related to organic components on the surface.

key areas of interest were sampled during the dismantling process. In addition to what was visible under UVA irradiation, several other adhesives were revealed once the vessel was taken apart, and eight samples of "adhesive materials" were taken for chemical characterization. Both transmission FTIR and ATR-FTIR were employed with these eight samples. As well, additional samples of structural materials were taken for characterization.

Adhesives. Two modern adhesives were identified on the Zapotec urn: cellulose nitrate, a semi-synthetic adhesive, and polyvinyl acetate (PVA), a synthetic adhesive. Although less common in conservation today, cellulose nitrate adhesives are still commercially available at hardware stores. PVA adhesives are still used in conservation and can be found in many common commercial adhesives, including Elmer's® glue.

Fourier transform infrared spectroscopy was used to identify the adhesives. The cellulose nitrate was found in two locations (indicated in red in Figure 12.9), and the PVA was found in six locations (indicated in blue in Figure 12.9). FTIR spectra of cellulose nitrate and PVA from the effigy are shown in figure 12.10, along with their respective reference spectra for comparison.

Figure 9: Zapotec urn showing the location of adhesives analyzed and the respective findings. Red lines indicate cellulose nitrate and the blue indicates PVA.

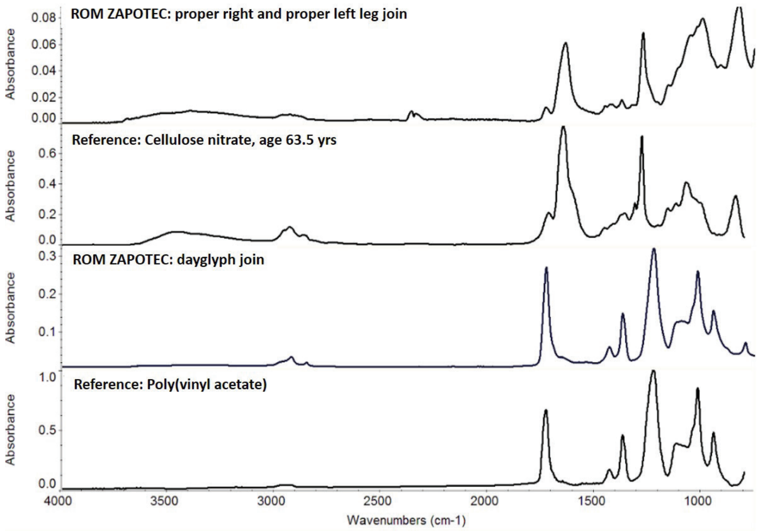


Figure 10: FTIR-ATR spectrum of the proper right and proper left leg joint compared with the reference spectrum of cellulose nitrate. In addition, the dayglyph joint spectrum is displayed along with the reference spectrum for PVA. Additional minor peaks are due to traces of ceramic in the sample (i.e. clay and iron oxide).

The identification of two types of adhesives may suggest either two different restoration campaigns, or an early repair done in the field by an archaeolgist or collector and a subsequent conservation treatment by a conservator. Cellulose nitrate was available as early as the late nineteenth century, whereas the PVA adhesive was more likely used around the time of World War II (Horie 2002, 94, 96, 133). Based on these findings and known periods of use of these adhesives, it is likely that the repairs done with cellulose nitrate pre-date those done with PVA.

Structural materials. In addition to the adhesive samples, several structural components were investigated, all of which were comprised of what the conservator described as a "rubbery putty." This material was hard and ceramic-like, but could absorb water and exhibit more rubber-like properties. The "rubbery putty" samples found under the lap plaque, left ear, nose, and shoulders (Figure 12.11, points 1–5) appear to be composed of a similar material. At the time of analysis, a variable amount of water was present in the samples from the de-restoration process (see Chapter 11). The putty is a complex mixture of materials. It appears to contain calcium carbonate (i.e., chalk), clay (i.e., kaolin), and possibly a proteinaceous binder (i.e., rabbit skin glue); a typical FTIR spectrum of a protein presents the amide I and II bands around 1650–1500 cm−1, and a broad nitrogen-hydrogen (N-H) stretching band around 3300 cm−1, all of which are present in these samples to variable degrees considering the composite nature of the samples (Figure 12.12). The proteinaceous binder would account for the putty's physical description ("rubbery")

Figure 11: Zapotec urn showing the locations of the rubbery putty samples (pts. 1-5) and the samples from the nose area (pts. 7, 8).

and ability to absorb water, as well as its fluorescing the typical greenish-blue colour seen in Figure 12.8 (Nel 2006).

Several other samples were analyzed but showed no evidence of organic binding materials. The nose tip and the bridge of the nose (Figure 12.11, areas 6 and 7) appear to be composed of calcium carbonate and an iron-rich clay.

Microchemical testing was performed to investigate the potential presence of a protein (Odegaard et al. 2000, 142–43). These types of tests rely on specific chemical reactions and/or a visual observation, such as a change in pH and/or colour. The test requires a known positive, known negative, and the unknown sample. In the case of the test for protein, the known positive was albumen (a globular protein, common in eggs) and the known negative was starch (a polysaccharide). The observation for this test was a change in pH, where an increase suggested the presence of a protein (the albumen gave a pH of 10–10.5), and no change suggested no protein was present (the starch gave no change: pH of 6–7.5). The sample of the "rubbery putty" from the left ear and left shoulder yielded an increase in pH (pH of 10–10.5), suggesting the presence of a protein. A sample from the bridge of the nose was inconclusive/negative (pH around 7–8), signifying that no protein was likely present in the sample.

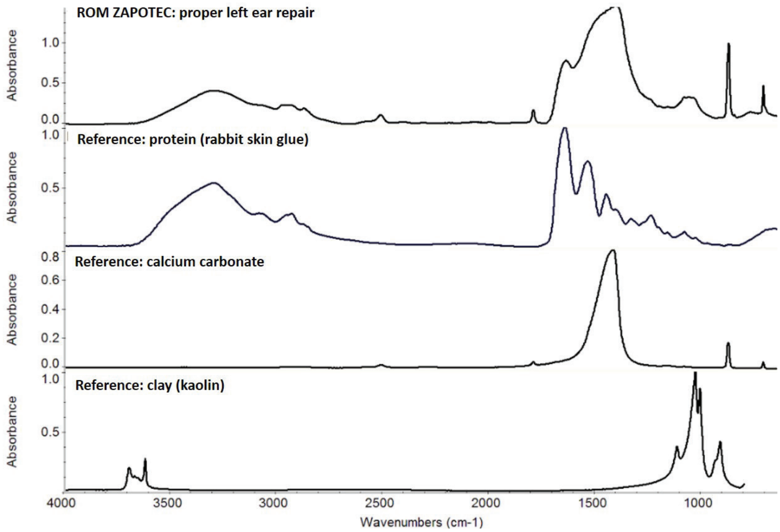


Figure 12:
μ-transmission FTIR spectra of the proper left ear repair compared to a protein material (rabbit skin glue), calcium carbonate, and clay (kaolin).

Conclusion

Although studies have documented the use of white, yellow, blue, black, and red pigments on ceramic vessels from the region (Aguilar-Téllez et al. 2014), only limited evidence for pigmented decoration on HM 1953 was found. This was expected, as the urn showed evidence of post-production manipulation. The only evidence of original decoration was in several protected areas containing red pigment, which were only revealed during the conservation treatment. Several analytical techniques revealed the use of both cinnabar and hematite as colouring pigments on the vessel. Although it is not always necessary to use a binder to adhere pigments to a ceramic, it can sometimes be found. These pigmented samples were severely under-bound and attempts to positively identify the presence of a binder were inconclusive. In the future, more sophisticated and sensitive imaging techniques may reveal other colours. For example, false-colour infrared imaging has been used successfully to identify pigments on ceramics and might be an applicable non-destructive method (Aguilar-Téllez et al. 2014).

UVA irradiation revealed evidence of organic compounds in the joins and in some larger general areas. Samples were analyzed by FTIR and showed the presence of both cellulose nitrate and PVA adhesives. These two adhesives are

not from the initial manufacturing of the urn and should be attributed to two restoration campaigns based on the known time periods of their preferred use.

Additional ceramic fill areas were analyzed and showed evidence of proteinaceous materials, indicating the possible use of a protein binder such as an animal skin glue. However, because of the large amount of inorganic material in these fills, it is difficult to reach a definite conclusion regarding the presence of a proteinaceous material. The UVA irradiation and fluorescence studies, microchemical testing, and tactile observations of the sample do support the theory that a protein is present. Additional analysis is required to make a firm conclusion, and possibly identify the source of the protein.

References Cited

Aguilar-Téllez, Dulce María, José Luis Ruvalcaba Sil, Pieterjan Claes, and Diana González-González. 2014. "False Color and Infrared Imaging for the Identification of Pigments in Paintings." *MRS Proceedings* 1618. Cambridge University Press: 3–15.

Alderson, Samantha. 2002. "A Technological Study of the Painted Surfaces of Zapotec Urns from Xoxocotlán." In *AIC Objects Specialty Group Postprints*, Vol. 9, compiled by Virginia Greene and Patricia Griffin, 146–60. The American Institute of Conservation of Historic & Artistic Works.

Burgio, Lucia, and Robin J. H. Clark. 2001. "Library of FT-Raman Spectra of Pigments, Minerals, Pigment Media and Varnishes, and Supplement to Existing Library of Raman Spectra of Pigments with Visible Excitation." *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy* 57 (7): 1491–521.

de Ágredos Pascual, María Luisa Vázquez, María Teresa Doménech Carbó, and Antonio Doménech Carbó. 2011. "Characterization of Maya Blue Pigment in Pre-classic and Classic Monumental Architecture of the Ancient Pre-Columbian City of Calakmul (Campeche, Mexico)." *Journal of Cultural Heritage* 12 (2): 140–48.

de Groot, S. and van Oosten, T. 2012. "Chemical composition/structural characterization using spectroscopic techniques." In *Preservation of Plastic Artefacts in Museum Collections*, edited by Betrand Lavédrine, Alban Fournier, and Graham Martin 43-49. Paris: Comité des travaux historiques et scientifiques

Down, Jane L., Maureen A. MacDonald, Jean Tétreault, and R. Scott Williams. 1996. "Adhesive Testing at the Canadian Conservation Institute: An Evaluation of Selected Poly (vinyl acetate) and Acrylic Adhesives." *Studies in conservation* 41 (1): 19–44.

Eastaugh, Nicholas, Valentine Walsh, and Tracey Chaplin. 2008. *Pigment Compendium: A dictionary and Optical Microscopy of Historical Pigments*. New York: Routledge.

Haude, Mary Elizabeth. 2013. "Identification of Colorants on Maps from the Early Colonial Period of New Spain (Mexico)." *Journal of the*

American Institute for Conservation 37 (3): 240–70.

Horie, C. V. 2002. *Materials for Conservation*. Oxford: Butterworth Heinemann.

Janssens, Koen, G. Vittiglio, I. Deraedt, A. Aerts, Bart Vekemans, Laszlo Vincze, F. Wei. 2000. "Use of Microscopic XRF for Non-destructive Analysis in Art and Archaeometry." *X-ray Spectrometry* 29 (1): 73–91.

Lafuente B, R. T. Downs, H. Yang, and N. Stone. 2015. "The Power of Databases: The RRUFF Project." In *Highlights in Mineralogical Crystallography*, edited by T. Armbruster and R. M. Danisi, 1–30. Berlin: W. De Gruyter.

Learner, Thomas J. S. 2004. *Analysis of Modern Paints*. Research in Conservation. Los Angeles, CA: J. Paul Getty Trust.

Nel, Petronella. 2006. "A Preliminary Investigation into the Identification of Adhesives on Archaeological Pottery." *AICCM Bulletin* 30 (1): 27–37.

Odegaard, Nancy, Scott Carroll, and Werner S. Zimmt. 2000. *Material Characterization Tests for Objects of Art and Archaeology*. London: Archetype.

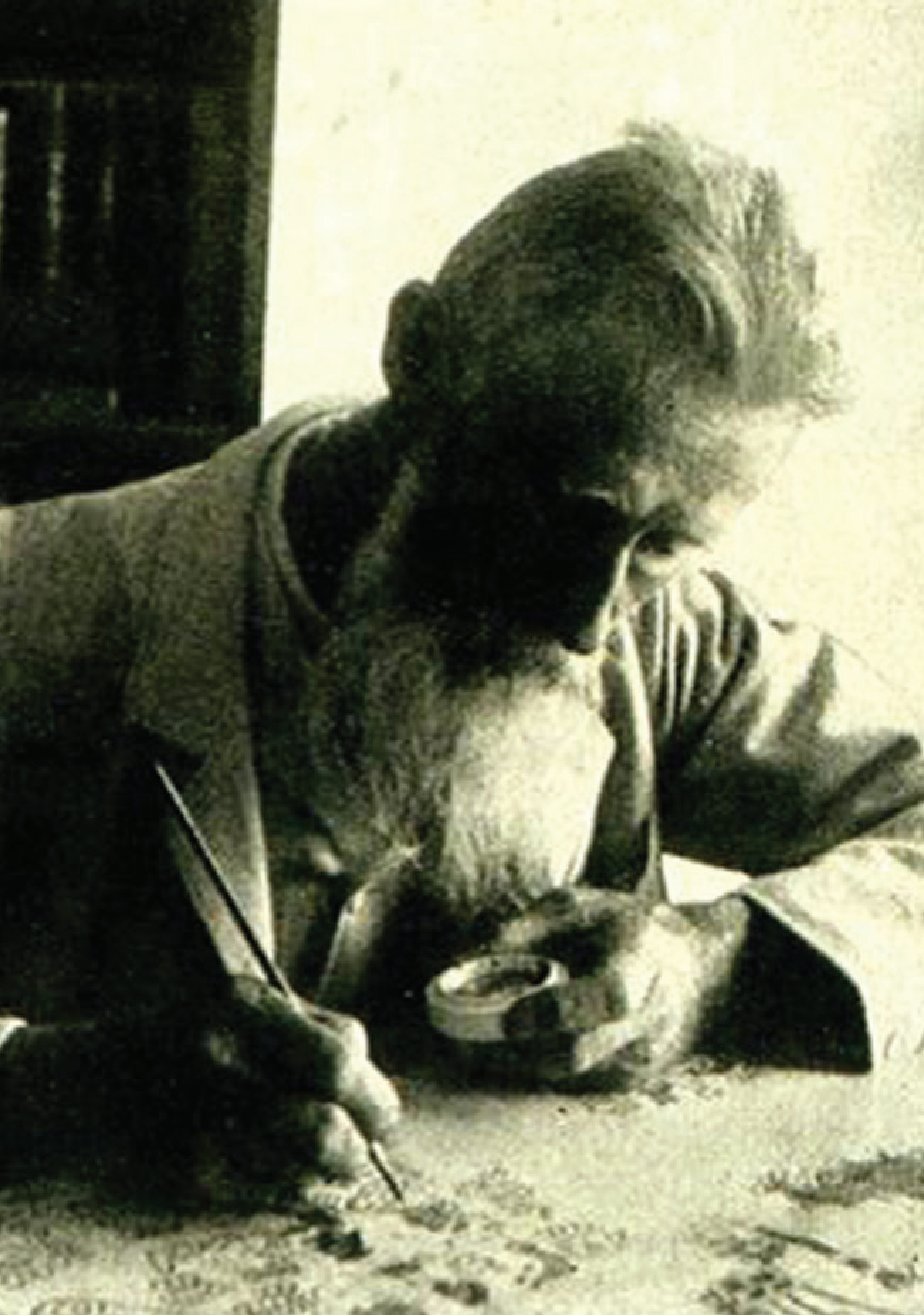
Rice, Prudence M. 1987. *Pottery Analysis: A Sourcebook*. Chicago: University of Chicago Press.

Ruvalcada Sil, José Luis. 2005. "PIXE Analysis of Pre-Hispanic Items from Ancient America." In *X-rays for Archaeology*, edited by M. Uda, G. Demortier, and I. Nakai, 123–49. New York: Springer.

Shackley, M. Steven. 2011. "An Introduction to X-ray Fluorescence (XRF) Analysis in Archaeology." In *X-ray Fluorescence Spectrometry (XRF) in Geoarchaeology*, 7–44. New York: Springer.

Shugar, Aaron N. 2013. "Portable X-ray Fluorescence and Archaeology: Limitations of the Instrument and Suggested Methods to Achieve Desired Results." *Archaeological Chemistry VIII*: 173–93.

Stuart, B. 2007. *Analytical Techniques in Materials Conservation*. Chichester: John Wiley & Sons, Ltd.



CHAPTER 13

Linking HM 1953 to a Possible Companion Urn in Berlin

CARLOS MORALES MERINO / RATHGEN-FORSCHUNGSLABOR, PREUSSISCHER KULTURBESITZ
STEFAN RÖHRS / RATHGEN-FORSCHUNGSLABOR, PREUSSISCHER KULTURBESITZ
ADAM T. SELLEN / CEPHCIS-UNAM
KAY SUNAHARA / ROYAL ONTARIO MUSEUM
ROBERT MASON / ROYAL ONTARIO MUSEUM
MARIA GAIDA / ETHNOLOGISCHES MUSEUM, PREUSSISCHER KULTURBESITZ
INA REICHE / RATHGEN-FORSCHUNGSLABOR, PREUSSISCHER KULTURBESITZ

Many Zapotec urns, especially those representing the deity *Cociyo*, were produced in series of four or five in response to an ancient worldview with ritual implications (see Chapters 2 and 3). Beginning in the nineteenth century, sets of this type of object were often divided up among collectors and museums (see Chapter 4), and tracking down the various parts of these original assemblages in museum collections has become a scholarly pursuit, although not a systematic one until this century.

In this chapter, we employ thin-section petrography and micro-X-ray fluorescence (μ-XRF) to investigate the properties of a vessel currently held in Berlin (IV Ca 26836), which we believe may have been a matching counterpart for HM 1953 (Figure 1).Thin-section petrography was performed at the ROM's Ceramic Petrology Laboratory using the method described in Chapter 10. Trace element analysis was performed in Berlin using μ-XRF; a different device from the one used to analyse HM 1953 was employed (see Chapter 9). As we shall see later, however, the results are qualitatively comparable because similar measuring conditions were taken into account.

In 1989, thermoluminescence dating (TL) using the fine grain technique (see Aitken 1985, 1978; Sutton and Zimmerman 1976; Shaplin 1978) and neutron activation analysis were carried out on IV Ca 26836 at the Rathgen-Forschungslabor (Rathgen Research Laboratory). Technical details are

Figure 1: Left: IV Ca 26836, Right HM 1953.

published in Goedicke et al. (1992). The 1989 analyses demonstrated that the urn was ancient; however, the TL date of 817–919 CE has to be reconsidered because of the limited sample quantity and the missing information about the regional annual dose (Goedicke, personal communication, September 2016). Stylistically, Boos (1966, 44) had assigned it to the old-system phase of IIIb (600–800 CE), but Schuler-Schömig (1970, 45) felt it should be earlier. Considering its characteristics, the most recent stylistic chronology suggests that it was most likely made in the Pitao phase (350–500 CE).

Acquisition History of Berlin Urn IV Ca 26836

Discussion of the Berlin urn's possible companions began with Immina von Schuler-Schömig. The curator for the Americas department at the Ethnologisches Museum (Ethnological Museum) in Berlin, she observed that the head from the figure of a fragmented Zapotec vessel from the collection of Howard Leigh in Mitla, Oaxaca (published in Boos 1966, 44, Figure 2) was an almost exact match of an object in their collection that was much more complete (Schuler-Schömig 1970, 45). Yet, she also commented that the objects had different reported provenances: the object in Leigh's collection (Cat. no.

1224; now in the collections of the Instituto Nacional de Antropología e Historia (INAH), Oaxaca), was reportedly from Ejutla, a town in the southern arm of the Central Valleys of Oaxaca, and the Berlin object had reportedly come from Xoxocotlán, a site situated at the southeast piedmont of Monte Albán (Figure 2). Schuler-Schömig was unaware that the ROM also possessed an object similar to these two fragmented urns.

In terms of iconography, the object from Berlin and the fragment of a head in the Leigh collection are very similar; however, there are differences that can

Figure 2: Left: Effigy vessel from the ex-collection of Howard Leigh, Cat. no. 1224 (Boos, 1996, vol. 2). Right: Effigy vessel in Berlin, cat. IV Ca 26836 (Schuler-Schömig, 1970: figure 34).

be observed. The detail covering the mouth on the Berlin urn consists of a large plate with two "fangs" on each side, while the same truncated feature on the Leigh urn shows a row of two teeth flanked by larger fangs. Upon close visual inspection of the Leigh urn, it was evident that the original detail had broken off and was replaced with a prosthetic detail made from either wax or some type of resin. The post above the nose is slightly different in both examples: the Berlin urn has two grooves cut into the second level, whereas the Leigh urn has only one groove. Only the Leigh urn has two indentations carved out of the first level above the mask (nostrils?). Finally, the proportions of some of the details, such as the beads in the headdress or the flower-like elements that decorated the

eyes, appear to be slightly different on both examples. These small differences suggest that the pieces, though similar, were not made at the same time and by the same artisan.

The Berlin object (IV Ca 26836) was collected in Xoxocotlán by the husband-and-wife team of Eduard Georg Seler and Caecilie Seler-Sachs, who carried out six field seasons in Mexico and other neighbouring countries between the years 1887 and 1911. The couple had visited the ancient mounds of Xoxocotlán many times and drew several detailed maps of the site (Figure 3), though it is unknown if they were present when the urn was unearthed or if they simply received this information from the collector who sold it to them.

During his tenure as head curator for the Americas Department in the Royal Museum in Berlin (now known as the Ethnologisches Museum, EM) Eduard Seler and his wife procured an astonishing number of objects for the institution—13,000 (Dolinski 1998, 7). The Selers were also responsible for the bulk of the Museum's holding of zoomorphic and anthropomorphic vessels from Zapotec culture. Object IV Ca 26836 had entered the museum in 1905 along with a large number of materials which are illustrated in Schuler-Schömig's catalogue of the collection; the object was also recorded as an ink drawing on a card from the museum's records (Figure 4).

As doubts about the authenticity of this type of material spread among scholars (see Chapter 4) the Berlin museum decided to undertake a collection-wide TL analysis. The examination revealed that 62 of the 233 Zapotec effigy

Figure 3: The archaeological site of Xoxocotlan, Oaxaca, showing Monte Alban in the background. Drawing by Eduard Seler, circa 1886. Photo courtesy of the Seler Archives, Iberoamerican Institute, Berlin.

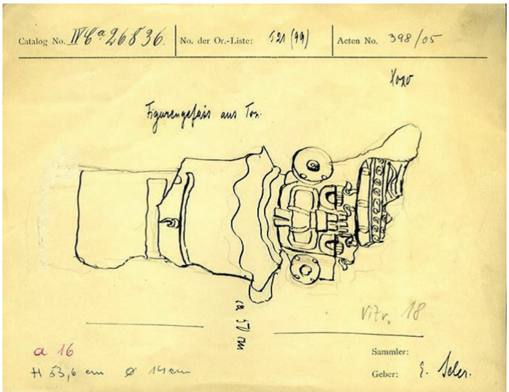


Figure 4: Ethnologisches Museum record card of the urn IV Ca 26836.

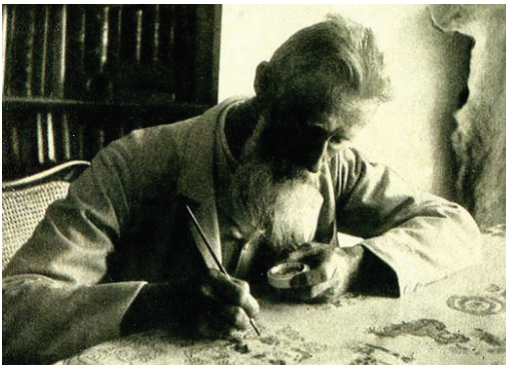


Figure 5: Eduard Seler copying the Lienzo de Tlalpiltepec in Constantine Rickard's residence in Oaxaca, circa 1907.

vessels had been produced in the twentieth century (Goedicke et al. 1992). It turned out that the Selers had collected almost all of the spurious effigy vessels between 1905 and 1911, indicating that the German couple had interacted with purveyors of fakes. During their time in Oaxaca they had been in contact with ancient material and had even participated in an excavation in 1895, leading one scholar to question how they were not able to distinguish the contemporary fakes from the ancient forms (König 2003, 331–32).

The collections that the Selers acquired in Oaxaca were not entirely constituted of fake materials but were a mix of contemporary and ancient objects. Some of these faux wares could have been supplied by the British consul, Constantine Rickards (Sellen 2004, 38–39), who the couple knew well because it was in Rickards's residence that Eduard Seler had spent a great deal of time copying the Lienzo de Tlapiltepec (Figure 5). Furthermore, the German scholar was undoubtedly acquainted with the consul's collection and the much more complete HM 1953 that is the focus of this book. But Seler makes no mention of the ROM's urn in his copious notes and drawings.

Description of Berlin Urn IV Ca 26836

The vessel is composed of a cylindrical body and features a figure on the front. The cylindrical body is open at the top and is made of coarse clay that is light grey in the core and beige/brown on the surface. The ceramic material used to create the figure is fine-grained clay that is also light grey in the core and beige/brown on the surface. On the face and headdress there are traces of a red pigment. The dimensions of the vessel are about 53.6 cm × 30 cm × 25.5 cm.

The figure is wearing a cape with a ruffled collar which, at one time, was partially missing. At some time and for unknown reasons, the collar was completed. This addition is made of gypsum and was painted beige/brown. Other parts which were added or repaired are shown in Figure 6.

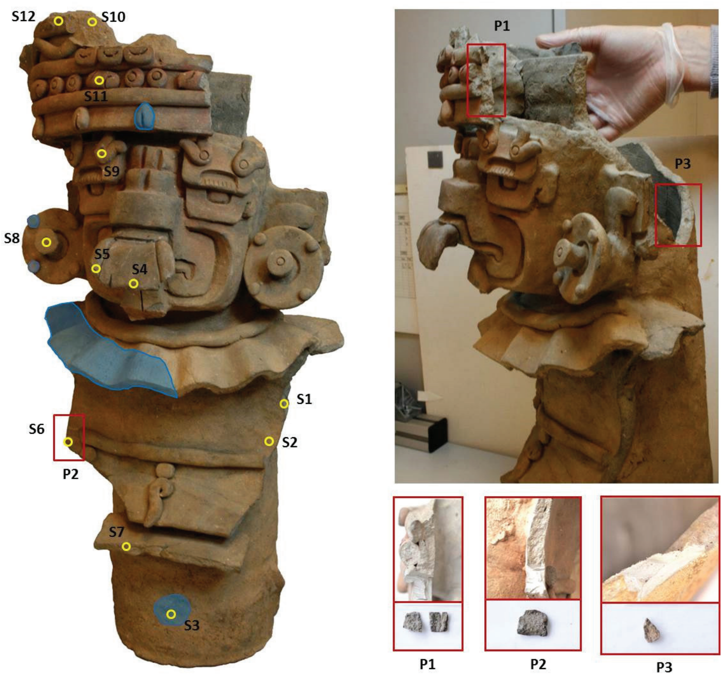


Figure 6: P1, P2, and P3 are the samples that were taken for thin-section petrography (bottom right), the corresponding breaking edges on the urn are showed on the left side and top right. Parts that were added or restored are marked in blue. P3 was also the location for TL dating.

Methodology

Three samples from the Berlin urn, labelled P1, P2, and P3 (Figure 6, bottom right) were sent for thin sectioning to ROM's ceramic petrology laboratory in Toronto. The locations were selected together with conservators from the EM, avoiding parts thought not to be original. Details of the petrographic analysis are described in Chapter 10.

Micro-XRF analysis was performed using a Bruker ARTAX spectrometer equipped with a Mo target, SDD, detector and a polycapillary to focus the X-ray beam. Measurements were collected using the following set-up: 45 kV, 500 μA current, accumulation time of individual spots typically from 50 to 100 seconds, He flux, and no filter. The working distance was about 1 mm and the spot size about 100 μm. The instrument has an XYZ motorized head and a camera-laser system for sample positioning.

As stated in Chapter 9, XRF is generally a surface sensitive technique (see also Behrendt et al. 2012). In order to avoid surface effects, if possible, measurements were made on breaking edge surface (locations S1, S5, S6, S7, S10, P1, P2, and P3; see Table 1). A total of 90 measurements were carried out in 15 locations (see Figure 6). Five measurements were carried out on each of locations S1–S12, within an area of about 3 mm in diameter. The final result for each location was the accumulated spectrum, in order to average the material heterogeneity because of the small spot size of the μ-XRF set-up. This step was necessary to make the analyses of both urns equivalent.

LOCATION	DESCRIPTION
S1	Breakage area of cape`s right edge
S2	Right edge of the cape, surface
S3	Lower part of the cylindrical body (restored area)
S4	Plate covering the mouth, middle, surface
S5	Plate covering the mouth, breaking edge surface
S6	Left edge of the cape, fresh breaking edge surface
S7	Breakage surface, cape`s lower part
S8	Central thorn, left ear spool
S9	Right "flower" on the left eye
S10	Upper part of the headdress, end of the interrupted undulating line, breaking edge surface
S11	Elongated bead on the headdress
S12	Upper part of the headdress, surface
P1	Headdress, fresh breaking edge surface
P2	Left edge of the cape, fresh breaking edge surface
P3	Location were the sample for TL dating was taken, fresh breaking edge surface

Table 1: Measuring locations.

The thin-section petrography samples were taken at P1, P2, and P3. Ten μ-XRF measurements on the fresh cut surfaces of each sample were also carried out (Table 1). The result here was also the average of the μ-XRF spectra. Additionally, the content of Rb and Sr on the breaking edge surfaces (S1, S5, S6, S7, S10, P1, P2, and P3) was quantified using the standards listed in Table 2. Sample location P3 corresponds also to the sampling spot of the TL dating from 1989 (Goedicke et al. 1992).

STANDARD	RB (PPM)	SR (PPM)
GBW-07108	32	913
GBW-07103	466	106
USGS D W-2	21	190
SARM 69	66	109
NSB98a	35	438
NSB97a	20	860

Table 2: Certified reference materials.

Results and Discussion

Petrographic analysis. The Berlin samples collectively comprise a petrofabric distinct from those found in the ROM urn and will be referred to as Petrofabric Group ZU5 (ZU stands for "Zapotec urn," Zapotec Urn", with petrofabrics ZU1 to ZU4 all found in various samples of the ROM urn).

As discussed in Chapter 10, petrofabrics are defined by identifying the mineralogical composition of a ceramic and the relative abundance of the non-plastic inclusions in that ceramic, as well as analyzing the size, shape, and sorting of those inclusions in thin-sections. Each of the three Berlin samples are consistent with one another and belong to the same petrofabric, ZU5, suggesting that this urn is essentially intact based on the sample locations.

Berlin urn petrofabric ZU5 comprises inclusions in a bimodal grain size distribution. The fine population consists of well-sorted, subangular, coarse to medium silt (mean of about 0.03 mm) comprising 8% quartz, 2% deeply sericitized (altered) feldspar, 2% opaques, and trace muscovite, perthitic feldspar, and felsic volcanic. The coarse population of ZU5 consists of well-sorted, subangular, medium sand (mean of 0.3 mm) comprising 8% felsitic volcanic (probably a rhyolite), 3% quartz, 1% sericitized (altered) untwinned feldspar (orthoclase), and trace amounts of plagioclase, perthite, amphibole, and rock fragments of a similar nature to that above (except the felsic volcanic).

Berlin ZU5 is superficially very similar to petrofabric ZU2 (the original core of the ROM object) and ZU1 (possibly ancient fragments from another urn attached in recent times). However, it is important to note the absence of

granophyric feldspar and the higher proportion of felsic volcanics in the Berlin urn samples (Figure 7). The similarities between the petrofabrics suggest that the urns may have come from the same part of Oaxaca, but the key differences in petrographic composition that we observed in thin-section indicate that the Berlin and ROM vessels were not made from the exact same source.

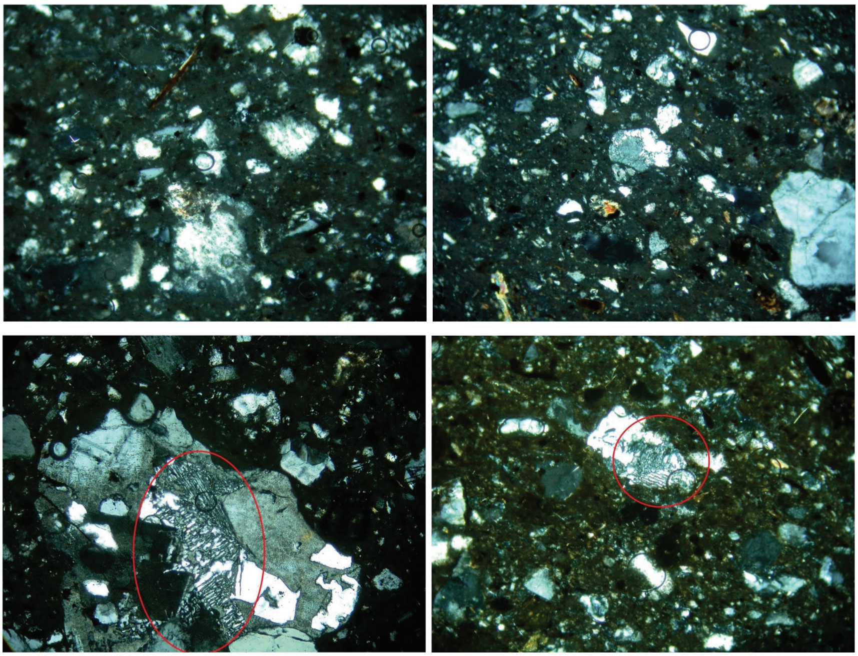


Figure 7: Comparative thin section micrographs, all views cross polarized light, 100X magnification: a) Top (left to right), Berlin IV Ca 26836, Samples #2 and #3, no granophyre present. b) Bottom (left to right), ROM HM 1953, Samples #5 and #9, granophyric texture in red circles.

Micro-XRF Analysis. A typical spectrum from the Berlin urn is shown in figure 13.8 (further spectra can be found in Morales Merino et al. 2016). The clay contains the elements Al, Si, K, Ca, Ti, Mn, Fe, Zn, Sr, Rb, and Y. The ratios of Sr/Rb, Y/Rb and RB/Fe are characteristic of the origin of the clays. According to the procedure described in chapter 9, the count rate ratios Sr/Rb, Y/Rb and Rb/Fe are shown in the scatter plots.

The plotted data on Figure 9 are scaled to those of Figure 3 in Chapter 9 in order to facilitate comparison. All data points from the Berlin urn do fall close together. This result suggests that the whole artefact was made of the same clay.

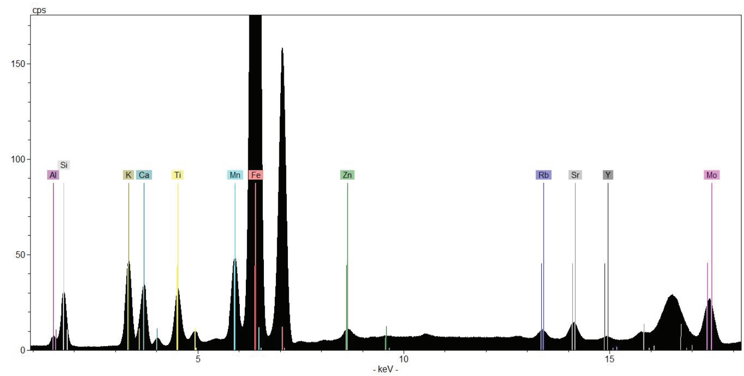


Figure 8: Micro X-ray fluorescence spectrum of location S4. The Mo signal is generated by the Rayleigh scatter from characteristic X-rays of the tubs anode material and the signal at slightly lower energy is the corresponding Compton scatter.

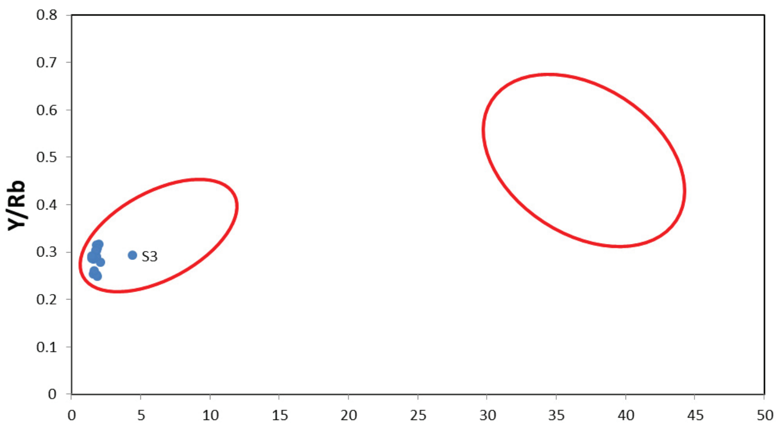


Figure 9: Plot of Y/Rb and Sr/Rb. The data plots into one group. The ellipse on the right corresponds to the group of "additions" in Figure 3, Chapter 9.

One exception is the data point from location S3, on the lower front part of the cylindrical vessel. A cavity is visible at this location in a historical photograph of the urn published in Schuler-Schöming's book (1970, Figure 34), which suggests some retouching of the object has been carried out at this spot. The presence of the filling material might be responsible for the deviation of S3 from the other spots. However, all the data points fall into group 1 from HM 1953 (indicated by the oval on the left side of Figure 9) which is believed to be the ancient part of HM 1953.

Figure 10 compares Sr/Rb ratios to Rb/Fe ratios. The Rb/Fe ratio measured with the μ-XRF is not comparable with measurements from the ROM because of the different instrument settings. The main difference in the two settings is the use of a filter on the excitation beam path of the ROM's Tracer XRF device. Elements which are neighbours in the periodic table, such as Rb, Sr, and Y, are not strongly affected by differences in the excitation of the analytical set-ups as they have very similar physical parameters (absorption edges, jump factors, fluorescence yield, etc.). The Rb/Fe ratio is more strongly affected by differences in the X-ray excitation. Therefore, a direct comparison of the Rb/Fe ratio from the two XRF devices is not valid.

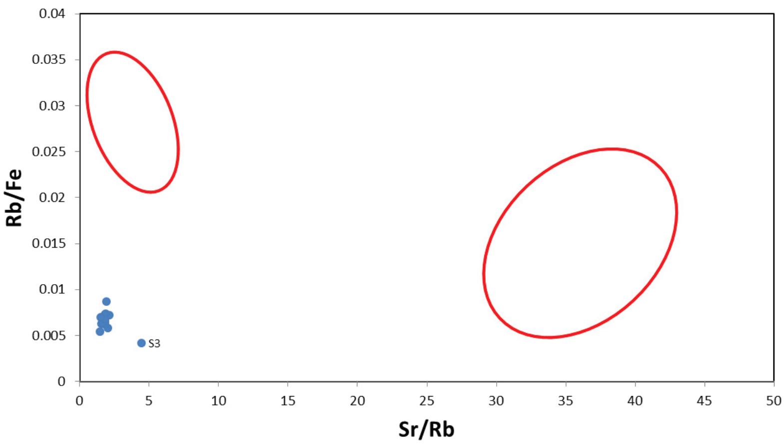


Figure 10: Plot of Rb/Fe and Sr/Rb. The data plots into a single group that falls lower to the group of original parts of HM 1953 (red ellipse).

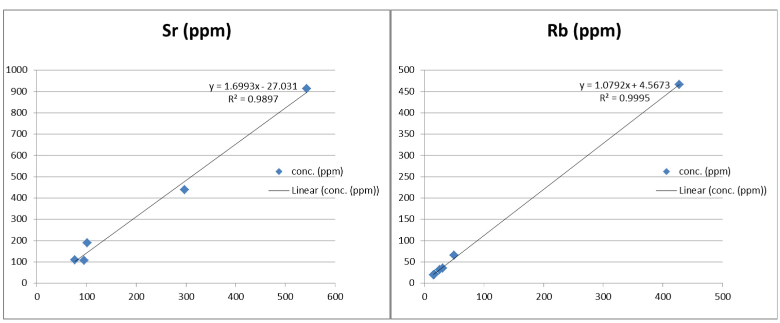


Figure 11: Calibration curves.

The plotted data comprises the data from breaking edges (with the light-grey core visible) and from locations where the brown/beige surface was analyzed. The tight grouping of the spots indicates that the surface has only a minor effect on the results of the elements Fe, Sr, Rb, and Y.

The Sr and Rb values of the urn have been calculated using certified reference material. The calibration curves are shown in Figure 13.11. The average values calculated from the spectra (excluding location S3) are Sr 260 ± 47 ppm and Rb 106 ± 13 ppm. The Rb value is in good agreement with the value of 96 ± 21 ppm given in Goedicke et al. (1992) and measured by NAA.

Conclusions

Zapotec urns were often made in sets of five, but when these urns were discovered they had often been separated into different collections. The striking similarities between Berlin urn IV Ca 26836 and ROM urn HM 1953 raise the possibility that they were part of the same set, along with a third urn found in the ex-collection of Howard Leigh in Oaxaca. The urns differ in detail, however, and their reported find spots suggested that they may have come from two different arms of the Oaxaca Valley.

The results of the petrographic analysis show that the raw material of the Berlin urn is, on the surface, very similar to that of the original core of the ROM object (petrofabric ZU1) but the absence of granophyric feldspar and a higher proportion of felsic volcanics in the Berlin urn indicate distinct sources of material for each urn, although possibly within the same region.

The results of µ-XRF analysis indicate that the whole urn was made of the same clay; these results are confirmed by the petrographic analysis. Moreover, the count rate ratios Sr/Rb and Y/Rb (Figure 9) of this clay plot together with the clay believed to be from the authentic part of HM 1953 (Chapter 9, figure 3).

The results of the XRF and thin-section analyses cannot definitively link the urns, but chemical and petrographic similarities in the paste suggest that the urns were made from closely related clay sources. Based on the geological data discussed in Chapter 9, HM 1953 was most likely made from clays obtained closer to Ejutla—the reported find spot for the urn in the Howard Leigh collection—rather than Xoxocotlán where the Berlin urn was reportedly unearthed. Expanding the petrographic sample of Zapotec urns to include examples from recorded contexts located in the Oaxaca Valley, especially Ejutla and surrounding region, has the potential to refine our understanding of the spatial and temporal relationship between the three stylistically similar urns.

References Cited

Aitken M. J. 1978. "Thermoluminescent Age Evaluation and Assessment of Error Limits Revised System." *Archaeometry* 18: 233–38.

——— 1985. *Thermoluminescence Dating*. London: Academic Press.

Behrendt, S., D. P. Mielke, and O. Mecking. 2012. "Die Portable Röntgenfluoreszenzeanalyse (P-RFA) in der Keramikforschung: Grundlage und Potenzial," *Restaurierung und Archäologie*, sonderdruck aus Jahrgang 5: 93–111.

Boos, Frank. 1966. *The Ceramic Sculptures of Ancient Oaxaca*. A.S. Barnes, New York.

Dolinski, Eckehard. 1998. *Caecilie Seler-Sachs 1855-1935: Una mirada amorosa al México de hace 100 años*, pp. 5-20, Catalogue of a photographic exhibition, Biblioteca de México, 1 August to 20 September, 1998, Instituto de Investigaciones Interculturales Germano-Mexicanas A.C., Berlin.

Goedicke, Christian, Sabine Henschel, and Ursel Wagner. 1992. "Thermolumineszenzdatierung und Neutronenaktivierungsanalyse von Urnengefässen aus Oaxaca." *Baessler-Archiv*, 40: 65–86.

König, Viola. 2003. "Eduard Seler y Caecilie Seler-Sachs en Oaxaca." In *Eduard y Caecilie Seler: Sistematización de los estudios americanistas y sus repercusiones*, edited by Renata von Hanffstengal and Cecilia Tercero Vasconcelos, 325–36. Mexico: CONACULTA-INAH.

Morales Merino, C., S. Röhrs, and I. Reiche. 2016. *Rathgen-Forschungslabor, internal Report* 84_092315

Sellen, Adam. 2004. "Is this the Face that Launched a Thousand Fakes?" *Rotunda* 36 (3): 32–39.

Schuler-Schömig, Immina von. 1970. *Figurengefässe aus Oaxaca Mexico*. Neue Folge, no. 20, Abteilung Amerikanische Archäologie I. Berlin: Veröffentlichungen des Museum für Völkerkunde.

Shaplin, P. D. 1978. "Thermoluminescence and Style in the Authentication of Ceramic Sculpture from Oaxaca Mexico." *Archaeometry* 20: 47–54.

Sutton, S. R., and Zimmerman D. W. 1976. "Thermoluminiscent Dating using Zircon Grains from Archaeological Ceramics." *Archaeometry* 18: 2.

CHAPTER 14

Conclusions

ADAM T. SELLEN (CEPHCIS-UNAM), JUSTIN JENNINGS (ROYAL ONTARIO MUSEUM), AND LAURA LIPCSEI (ROYAL ONTARIO MUSEUM)

Using tools from archaeology, art history, conservation, and material studies, this study tells the rich story of the creation of a Zapotec urn. HM 1953's biography can be divided into two parts: its first life in the remote past, when it was made, used, reused and eventually buried; and its second life, beginning almost a thousand years later at the end of the nineteenth century, when it was discovered, restored, collected, repaired, exhibited, and then finally deconstructed or "de-restored" for this project. During this second life, the urn acquired new parts, some newly constructed and others salvaged from ancient remains.

Zapotec urns, like other archaeological objects, are usually collected by museums to represent a particular past culture. Museums thus tend to force acquisitions into essential categories like "Maya," "Viking," or "Jomon," ignoring features of the objects that do not fit this description. These same essentialized categories lead us to judge some things as "real" or "fake" based on when they were first made. Thinking in terms of lives or biographies, however, compels us to look at the entire history of an object (Holtrof 2002). Simultaneously real and fake, composite objects like HM 1953 often have a particularly interesting story to tell.

Since its arrival at the Royal Ontario Museum, many have been struck by HM 1953's fantastic imagery and elusive meaning. Yet, it was also obvious that the piece was, at best, incomplete and heavily restored. HM 1953 did not fit perfectly into our interpretive framework of what an ancient Zapotec urn should look like. For this reason it was condemned to a box in the storeroom. Fortunately, we decided to take a second look. While gaps in the historical record and the limitations of some analytical techniques mean that we are unable to detect or fully understand all of the key moments in this artefact's long life, the story we have stitched together from a fragmentary record has enriched our knowledge of the object and reinvigorated our study of the ROM's Zapotec urn collection. Above all, our efforts showcase the value of an interdisciplinary approach in the analysis of museum materials.

Writing an Urn's Biography

How does one tell the story of an object? Our systematic visual assessment of HM 1953 hinted at its complex history. Under visible and UV light, we saw that a thin grey slurry had been hastily applied over the object to conceal substantial repairs, and we could make out joins and fillers—even different clay colours used to replace the missing features of the original. Faced with a confusing panorama of body and decorative parts grafted onto a cylinder and then disguised as ancient, we needed to dig further into the archaeology of the Zapotec, the archives of the ROM, and, ultimately, into the very fabric of HM 1953.

Understanding our urn meant bringing together specialists from a wide range of fields. Knowledge from archaeology and anthropology illuminated the original cultural context of HM 1953 by highlighting the deep cosmological significance of the effigy vessels for the ancient Zapotec. We complemented those findings with an extensive archival search of the object's collection history, to understand how it had been acquired and exhibited over time. Our research led to the discovery of century-old photographs showing the object in a private collection, key evidence that helped the ROM's conservator map aspects of the urn's evolution and identify when it had been originally restored. Broadening our search, we also located possible companion urns for HM 1953 in other museums and sought to clarify the murky connections that related them.

Our second approach involved experts in other fields whose work allowed us to understand the object's materiality through a battery of investigative techniques often used in conservation. Systematic visual assessment was just the first step. We looked below the surface of the object with X-rays, and later a CT scan, which revealed more cracks and joins, but also, astonishingly, modern brass wire used to attach the limbs. De-restoration meticulously melted away the water-soluble pastes that appeared to hold parts of the urn together. (And in the process released a fetid stench that had been in stasis for over a hundred years!) Meanwhile, we used thermoluminescence to relative date the various components of the urn, and X-ray fluorescence (XRF), ceramic petrography, Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, and optical microscopy to better understand the urn's clay, pigments, and adhesives.

Based on our examination of Zapotec archaeology, ROM archives, and HM 1953 itself, a complex picture emerged: HM 1953 is a composite of diverse parts, both ancient and contemporary, that were attached to an ancient core using a variety of substances, presumably to give the appearance of a complete object. These discoveries led us to wonder: How was the urn originally used? What materials were added and when? What can we say about the origin of these materials? By stripping the urn down to its original matrix, we were able to understand how it was manufactured, assembled, and restored—both in antiquity and in modern times. When these data were combined with those gleaned from archaeological and archival research, a more complete picture of

the ancient object emerged that could be used to evaluate its relationship to similar urns that we had identified in other museum collections.

HM 1953's Early Life

The central core of HM 1953 is composed of the cylinder, most of the face and headdress adornments, and a fragment of the loincloth, and was fabricated sometime between the fourth and fifth centuries CE in the Valley of Oaxaca. The general dating of these ancient parts comes from a visual inspection of the object and was later confirmed by the thermoluminescence dating technique. The urn was also dated based on an iconographic and stylistic assessment of what we considered to be its original features. Once the ROM's urn was de-restored, important diagnostic features that had been obscured by a spurious intervention sometime in the early twentieth century were now missing, such as the nose and mask assemblage. Fortunately, our observation that the urn was originally part of a set of companion urns helped us complete the picture. Coming from a similar Cociyo effigy set, urn IV Ca 26836 in Berlin illustrates what the nose gear of HM 1953 likely would have looked like in antiquity: a curved and protruding plaque flanked by two large fangs. Along with other attributes, such as the distinctive ruffled collar, this style of teeth on Cociyo effigy vessels places the urn squarely in the Pitao phase (350–500 CE).

A visual inspection of the urn also revealed faint traces of red pigment in the crevices of the face, near the eyes and around the mouth, headdress, and ear spools. The analysis of the pigments confirmed both iron oxides (hematite) and cinnabar (mercuric sulphide). Both of these elements are indigenous to the Oaxaca region and have been found on museum materials excavated over a century ago and on recently excavated urns. From studies carried out on other effigy vessels, we know that the pigments can be applied separately or mixed together to give different tonalities of red. Cinnabar is a rarer and brighter pigment, and evidence suggests that it was used to highlight certain features on urns, perhaps as a way of indicating status (Alderson 2002, 150).

In ancient Oaxaca, red pigment was applied to architectural details and artefacts, but also to human remains discovered in funerary contexts that range from simple to complex, suggesting that its presence indicates something more than status. One possible explanation for the polyvalence of red pigment on artefacts is that it represents a divine color, and refers to a mythical time when the deities walked the earth (Sellen 2007, 141–42). Today the red pigments on HM 1953 is poorly preserved and barely visible to the naked eye. What does remain is covered by a thin wash of grey slip. Berlin's urn also has little discernable pigment, and it may have been scrubbed off at some point. The similar Cociyo urn in the Oaxaca Museum, however, appears to have been untouched by these destructive processes, and its surfaces, reticulated with root imprints from having been buried, still bear the evidence of bright red pigment.

As we discussed in Chapters 2 and 3, while some urns are found in contexts that are not funerary the vast majority are associated with tombs and graves, and this is probably the case with HM 1953. We have also emphasized throughout this book that the ancient Zapotec would often produce Cociyo urns in series of four or five; and supported by the partial glyphic evidence displayed in their headdresses, HM 1953, the Berlin urn, and the Oaxacan Museum fragment could be companion urns from a larger set or at least all made to honour the same ancestor. Associated with the coefficient five that can still be seen on the ROM urn and on the two objects from Berlin and from Oaxaca, the original glyph would have been one of the 20 day names from the Zapotec ritual calendar, and taken together (5-?), named an ancestor of high status. As a set they were placed, as customary, in front of a tomb or perhaps on the tomb's roof. The sheer size of the objects and the amount of space they occupy would preclude them being placed inside the tomb given that most structures are only about a meter and a half wide.

Through our studies we moved closer to locating the urn's precise origin in the Valley of Oaxaca. Samples taken from the urn and analyzed using thin-section petrography disclosed that the fabric of the clays used to manufacture the ancient parts could be sourced to the volcanic terrains in the southeast regions of the Valley, in a granophyric outcrop that intrudes into the Precambrian Oaxaca Complex near the town of Ejutla. While more study is needed to confirm this possibility, the evidence coincides with the reported provenance of Ejutla for the urn head fragment—identical to HM 1953—currently held in the Oaxacan Museum. During the Classic period, Ejutla was one of the 15 largest communities in the Central Valleys and archaeological studies have shown that it was home to a thriving ceramic industry with localized workshops (Feinman and Nicholas 1995). The Berlin urn, on the other hand, is reportedly from Xoxocotlán, an important pre-Hispanic site some 50 kilometers north of Ejutla. While the Berlin urn's petrofabric is similar to the original core of the ROM's object, it was not made from the same source of clays as HM 1953.

This information can help us explain another mystery. In terms of visual details, HM 1953 and the head in Oaxaca are identical in almost every way, a characteristic we see in matching sets of Zapotec urns that have been excavated. The Berlin urn, however, displays a few minor differences from the other two: an extra notch above the nose, a lack of "nostrils" on the nose, and minor variations in the proportions of some of the decorative elements. These minute details may just point to the fact that the individual objects in a set were worked by several hands and not mass-produced to the exact same specifications. Yet, the simplest explanation, fitting with the petrographic analysis, is that the Berlin urn was made at a different place in the Valley of Oaxaca and does not belong to the set as we originally hypothesized.

If the Ejutla and Xoxocotlán find spots are accurate, then this may indicate that artisans during the Pitao phase were making very similar sets of

urns (in terms of size and iconography) at different locations in the Valley of Oaxaca. The similar ancestor name shared by the three urns would then be a coincidence. Another possibility is that the urns actually do come from the same "set," but were made at different times. Zapotec tombs are dynamic interments, so when a deceased family member was placed inside the tomb, the urn offering was uncovered and perhaps renewed. In the process, one of the objects may have been damaged, requiring family members to make another to complete the set. If this was the case, it could explain why the composition of the clay from the Berlin urn is similar (from the same region), but not identical, to the clay from HM 1953.

HM 1953's Later Life

When HM 1953 and its companion urns were discovered, sometime in the late nineteenth century, they were in a highly fragmented state—perhaps jostled by one of Oaxaca's many earthquakes, shattered by a passing plough, or crushed by a careless excavator's pick. Researching how these objects have been found in an archaeological context confirm this view, but we also have an insightful observation from the ROM's ceramic conservator. When she disassembled HM 1953 she noticed that the legs did not fit the object, that is to say they are from an ancient urn, just not this one. Since our XRF study confirmed that the legs are from the same clay source as the rest of the ancient parts, the simplest explanation is that HM 1953's legs are from a companion urn belonging to the same set. This evidence suggests that the person or persons who discovered this set attempted to make one whole urn out of fragments from the others. We also believe that the same is true of the left ear spool, which does not fit neatly on HM 1953 and shows signs of being heavily repaired. It would appear that some fragments were used to make a whole piece, while others were divided up among different collectors; there may be more fragments of the set housed in private or public collections that we are unaware of.

We also have evidence that in the particular workshop where HM 1953 was re-assembled, the artisan used a fragment from a completely unrelated urn to replace HM 1953's day glyph that had broken off. The piece that was used in place of the day glyph is the representation of a bird's wing, and the results of TL, XRF, and thin-section petrography confirm that it comes from another ancient urn unrelated to this set. We also observed that three impressions were made of the ancient wing fragment and attached to the loincloth of HM 1953, either to embellish it or perhaps just to cover the visible joins of a major repair. Another impression of this very same bird wing appears in the headdress of a fake urn in the British Museum (AM 1908,0718.7). Considering that both these objects entered private collections around the beginning of the twentieth century, we think it probable they were fabricated in the same workshop, perhaps by the same person.

While more work is needed to identify the location of these workshops and their associated artisans, thin-section petrography of the modern additions to HM 1953 point to the vicinity of Santa Maria Atzompa, a community about 5 km from the city of Oaxaca that in pre-Hispanic times was a satellite of the ancient city of Monte Albán. The potters of Atzompa form part of an enduring tradition, and still today produce spectacular wares using ceramic techniques and clay sources dating back thousands of years (see Brulotte 2012 for a discussion of a similar artisan community in Oaxaca). A deeper study of the ROM's Zapotec urn collection has led us to believe that Constantine Rickards, the collector who sold his entire cabinet to the ROM in 1919, was actively buying urns from potters in Atzompa, using originals in his collection to inform the fabrication of fakes and pastiches, and then distributing these wares among friends, colleagues, and unsuspecting museums. But we cannot discount the agency of Atzompa's potters in this caper, as it would appear that HM 1953 was a result of their ingenuity.

The de-restoration of HM 1953 by the ROM's ceramic conservator did not simply reveal the add-ons and techniques used by Oaxacan potters in the early twentieth century to make the urn "whole" again, but also in fact discovered two distinct restoration campaigns, with the later one occurring at the ROM. The initial campaign, carried out by someone who, shortly after their discovery, came into possession of the original core of HM 1953 and other assorted fragments, added poorly fired clay features to the main core—the left arm, part of a knee, the caped shoulders, the headdress flanges, and the loincloth and its decoration—and rebuilt part of the nose and the left ear spool. Also at this time a feature from another ancient urn was affixed to the headdress. These items were attached to the core using materials that were common at the turn of the last century: clay and animal glue.

When the urn finally arrived at the ROM in 1935, much of this initial restoration had come undone while in transit, so before the urn was placed on view in the Middle American Collections, sometime around 1940, it was repaired using brass wire to fasten the legs, arms, and loincloth to the central core. An analysis of the materials used show that an adhesive containing polyvinyl acetate (PVA)—basically wood glue or white glue—and rubbery brown PVA putty were applied to the joints in an attempt to hold everything together. No record of this restoration can be found in the archives; nonetheless, PVA as an adhesive was not used before World War II and so this restoration campaign must have occurred after the object arrived at the ROM.

A Really Fake Urn

In 1999, the first author of this chapter and a team of Mexican researchers were deciding which Zapotec effigy vessels in the ROM's collection would be good candidates to undergo tests to determine authenticity and to chemically characterize their ceramic bodies. Gingerly, we pulled HM 1953 out of a box where it had languished for decades, fearful it would come apart in our hands.

Curious, and at the same time confounded by the clear evidence of repairs and restorations, we put it back in the box, because we were unsure of how to approach such a monstrous pastiche. Since “inauthentic” objects are red flags to museum researchers, a common response is to push them aside in favour of “real” objects that best embody past cultures. Yet, we also like a good mystery, and in this case our desire to know more about this enigmatic object eventually led to the creation of a multinational, multidisciplinary team of scientists determined to tell the story of an object that is both “real” and “fake.”

But the story does not end here. With the de-restoration complete, we face a new reality: how should we present this object to the public? Do we leave it with parts missing and gaping holes? Should we reconstruct the effigy vessel so that it is more readable and understandable as a figure? Or, should we leave it as is—in a state similar to how it was found in its archaeological context? If we leave it as is, it would look very much like its counterpart in Berlin, even though this piece has also been lightly restored. The ROM’s curator for Latin American archaeology will no doubt have to grapple with these questions.

Every object in the museum tells a story. We have told what we know of HM 1953’s story to the best of our ability. We know it will continue to challenge and excite those who continue to write it long into the future.

References Cited

Alderson, Samantha. 2002. “A Technological Study of the Painted Surfaces of Zapotec Urns from Xoxocotlán.” In *AIC Objects Specialty Group Postprints*, Vol. 9, compiled by Virginia Greene and Patricia Griffin, 146–60. The American Institute for Conservation of Historic and Artistic Works.

Brulotte, Ronda L. 2012. *Between Art and Artifact: Archaeological Replicas and Cultural Productions in Oaxaca*, Mexico. Austin: University of Texas Press.

Feinman, Gary, and Linda M. Nicholas. 1995. “Especialización artesanal en Ejutla prehispánico.” In *Cuadernos del Sur* no. 10 (3): 37–56, Mayo-Agosto, Revista del IISUABJO, IIHUABJO, CIESAS-Oaxaca, INAH-Oaxaca, INI-Oaxaca, Mexico.

Sellen, Adam. 2007. *El Cielo compartido: las vasijas efigie zapotecas*, serie Monografías 4, Centro Peninsular en Humanidades y Ciencias Sociales, Merida, Mexico.

PHOTO CREDITS:

Brian Boyle: pp. 16, 210. 360-degree rotational photograph of urn; from Frank Boos (1996): p. 116; from Arni Brownstone (2015, p. 152): p. 249; Elbis Dominguez: Figures featured in pp. 31–67; Ethnologishes Museum: pp. 116, 208; Laura Lipcsei: pp. 158 (figure 1, right), 206, 212–215, 218–219, 236, 250; Ángel Ramírez Luna: 165–173; Carlos Morales Merino: p. 246 (figure 2, left); from Andrew Middleton (1997, p. 69): p. 123 (figure 12);Royal Ontario Museum Archives: 103; Adam T. Sellen: pp. 75 (map), 76, 77 (figures), 84, 96, 107, 125, 128–129, 246 (figure 2, right); Paul Shao: 100; from Philippa Shaplin (1975): p. 123 (figure 11); Heidi Sobol: 152 (left); Shawn Stapleton: 150, 152 (right), 155 (Box 2.1, top), 156, 158–162; Susan Stock: pp. 141–149; Javier Urcid: p. 34; Tara Winterhalt: 155 (Box 2.1, bottom).

MUSIC CREDITS FOR VIDEOS:

Chapters 1 and 14:
Rite of Passage by Kevin MacLeod
http://freemusicarchive.org/music/Kevin_MacLeod/Global_Sampler/Rite_of_Passage

Chapter 4:
Edge of Sanctuary by Art of Escapism
http://freemusicarchive.org/music/Artofescapism/Strange_Jazz_Abstract_Jazz/Edge_of_Sanctuary

Chapters 8 and 9:
Green Evolution (Paid Track $$)
http://retired.sounddogs.com/production-music/green-evolution-ambitious-uplifting-745555

Chapter 10:
Inversions – Part 2 by TRG Banks
http://freemusicarchive.org/music/TRG_Banks/Inversions/Inversions_-_Part_2

Chapter 11 De-restoration:
Overflow of Time by Art of Escapism
http://freemusicarchive.org/music/Artofescapism/Sound_Forest_Atmospheric_Tracks/Overflow_of_Time